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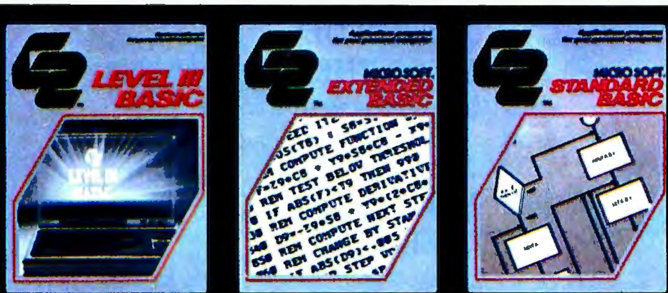

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CIRCLE 35 ON INQUIRY CARD

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Editorial onComputing

A New Magazine

Chris Morgan
Editor-in-Chief

The other day a friend asked me, "Just what do you *do* with a personal computer?"

"Do you have half an hour?" I chuckled. "For starters, there are computer games, gadgets that let your computer talk and listen to you, educational programs that teach mathematics and other subjects, programs that help you type letters, do your income tax, keep address records up to date, make an index, draw color pictures on your TV set, play chess, perform magic (my own particular passion), and on and on. Oh—they keep your syntax in line, too."

"You mean they correct your grammar?"

"If you're speaking their language, they do."

"Ah, so I have to know how to program to use one."

"Not really. You can buy programs that are already written, plug them in, and use them. But programming can be a lot of fun."

"Great! How do I get started?"

* * * * * *

How *do* you get started?

The question comes up so often in our mail at *BYTE* magazine (where I've served as senior editor and editor-in-chief for the past two years) that we decided to start a magazine to answer it. We also sensed the need for a publication devoted to the educated computer user rather than the computer professional. If you're fascinated by personal computers but get a little bewildered by computer jargon or the dazzling array of new computer products on the market, onComputing is for you. We'll also try to answer other questions, such as:

> What computer should I buy?
> What books are best for the beginner?
> Where can I buy a computer?
> What can I do with my computer once I get it?

In each issue we'll show you what other people are doing with their personal computers around the world. Some of the applications may surprise you.

Personal computers have arrived. Why the sudden interest? There are many explanations: personal computers are dependable and patient (anthropomorphic adjectives are irresistible when you've worked with these machines for any length of time), and are literally blank slates onto which you can project your ideas—"brain amplifiers," in the phrase of Carl Helmers (editorial director of both *BYTE* magazine and onComputing).

Sometimes they offer an escape from our everyday problems, and sometimes they offer new solutions. They are many things to many people: an arithmetic teacher for children, a calculus calculator for the mathematics teacher, a fairly decent chess partner whenever you want one, and a "memory jogger" when you forget.

But mostly, they're fun.

These ubiquitous tools are beginning to crop up in prime time TV commercials. Over 1000 computer stores have sprung up worldwide; personal computer conventions attract 15,000 hackers (computer addicts) at a throw; Milton Bradley and other companies are offering toys with built-in microcomputers; and other companies (like Mattel and Atari) are offering units that bridge the gap between video games and personal computers.

Where will it all end? We don't know, but we'll keep you informed in future issues of onComputing. And who knows, I might be persuaded to part with my magic program in an upcoming issue! ■

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Color. VP-590 add-on Color Board allows program control of 8 brilliant colors for graphics, color games. Plus 4 selectable background colors. Includes sockets for 2 auxiliary keypads (VP-580). $69.*

Sound. VP-595 Simple Sound Board provides 256 tone frequencies. Great for supplementing graphics with sound effects or music. Set tone and duration with easy instructions. $24.*

Music. VP-550 Super Sound Board turns your VIP into a music synthesizer. 2 sound channels. Program control of frequency, time and amplitude envelope (voice) independently in each channel. Program directly from sheet music! Sync provision for controlling multiple VIPs, multitrack recording or other synthesizers. $49.*

Memory. VP-570 RAM Expansion Board adds 4K bytes of memory. Jumper locates RAM in any 4K block of up to 32K of memory. On-board memory protect switch. $95.*

EPROM Programmer. VP-565 EPROM Programmer Board comes complete with software to program, copy and verify 5-volt 2716 EPROMs—comparable to units costing much more than the VP-565 and VIP put together! Programming voltages generated on board. ZIF PROM socket included. $99.*

EPROM Interface. VP-560 EPROM Interface Board locates two 5-volt 2716 EPROMs (4K bytes total) anywhere in 32K of memory. VIP RAM can be re-allocated. $34.*

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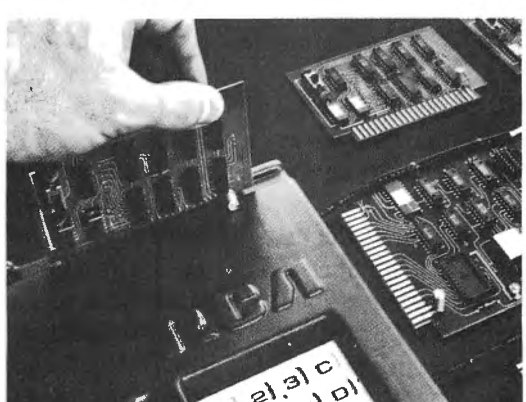

With these new easy-to-buy options, the versatile RCA COSMAC VIP (CDP18S711) means even more excitement. More challenges in graphics, games and control functions. For everyone, from youngster to serious hobbyist. And the basic VIP computer system starts at just $249* assembled and ready to operate.

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*Suggested retail price. CDP18S711 does not include video monitor or cassette recorder.
**Available 1st Quarter, 1979.

See the RCA VIP at the 3rd Annual National Small Computer Show at the New York Coliseum, August 23-26, booth 4211.

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The fun way into computers.

RCA

Getting Started

by Elizabeth M Hughes

Fear of an expensive mistake.

That's the problem besetting many people who want to enter personal computing. They're afraid their limited knowledge of computers will cause them to make an expensive mistake. The numerous alternatives offered by the manufacturers are dazzling — but they can also be bewildering, especially if the jargon used by advertisements is unfamiliar. What if you buy a "complete" system only to discover it's *in*complete — without the addition of programs, or input and output devices, or something equally important — at additional cost? Worse still, what if you outgrow your shiny new system in a year?

This article is intended to provide some of the information you need if you are to approach the selection of your personal computer system on a solid basis. We'll talk about what goes into a system, ways in which you can fill various needs, and prices. But, most important, we'll see how what you want to do with your system will influence your choice. First, though, let's see what goes into a computer system.

Bare Necessities

Obviously, a computer system requires something that does the actual computing. This is the central processing unit (CPU) and it is the heart of the computer. The abbreviation MPU (for microprocessor unit) is often used these days and it means the same element in the system. The difference is that a microprocessor packages all the circuitry of a central processing unit (and often some additional necessary or convenient circuits as well) on a single integrated circuit (IC). [*In onComputing we will use the term "processor" when referring to a microprocessor unit . . .* ed] When you consider that a modern microprocessor is usually faster, more powerful, and has lower power requirements than the large computers of ten years ago, it's a pretty impressive piece of technology.

The next necessity is program and data storage in the form of programmable memory. This is what holds the program the computer runs and the data it operates on. Information is stored in a computer in *bits*, each of which can represent one of two states, 1 or 0, on or off, true or false. Since this is too small a unit to hold a convenient amount of data, the actual portions of memory the computer addresses and uses are called *bytes*. Eight bits are usually treated as one byte, but you may encounter references to 4 bit bytes and other nonstandard sizes. If larger units, multiples of bytes, are commonly used by the processor (for instance 16 bits), they are usually called *words*. How much memory you need will depend on the sort of job you want

Elizabeth M Hughes came to computing from logic and philosophy, which she taught at college level before becoming a professional freelance writer.

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When you start looking for any addition to your system, be sure that it is possible to use it with your particular computer.

the computer to perform, but you can easily compare how much programmable memory comes with a given microcomputer system by studying the advertisements. 1 K bytes of memory is 1024 bytes; thus, 4 K bytes is 4096 bytes, and so on. [*1 K represents 1024 rather than 1000 because 1024 is a power of 2 (2^{10}, in fact) . . .* Ed] Usually the advertisement will specify if something other than 8 bit bytes is being measured.

To represent data inside the computer, codes of 1s and 0s are used. The binary number system permits representation of numbers using just these two symbols, and accepted conventional codes — most notably ASCII (*A*merican *N*ational *S*tandard *C*ode for *I*nformation *I*nterchange) — are used to represent letters of the alphabet and other nonnumeric symbols (see "The Binary World," by Russell Reiss, page 20). This brings us to the third necessity: a way to store data in memory.

Most of us assume that the computer does the job of storing data in memory; that all that's required is to tell it what we want stored. But without instructions, a computer doesn't know what to do with a piece of data. Before it can file data away in memory, it must have a program which:

(a) Lets it recognize that something given it *is* a piece of data.
(b) Lets it determine where in memory the piece of data is to be stored.
(c) Instructs it to store the piece of data there.
(d) Tells it what to do next, such as to go look for another piece of data to store.

Some home computer systems remedy this problem by making available to the processor a prewritten program to handle this sort of need. Generally, this program is stored in read only memory (ROM) and the processor is instructed to execute it the moment it is powered up. Read only memory cannot be used by the processor for storage, but only for the retrieval of a preset group of instructions or data.

A common alternative technique for storing data in memory is to use a *front panel,* so called because it originally was, literally, the front panel of the computer; although now many configurations for front panels are in use. A front panel has switches on it which are wired in such a way that by setting the switch position one can store the byte of data represented by the switches directly in memory, for example. Usually lights on the front panel provide an additional indication of what data is being stored and reflect the processor's activity while a program is being run.

Mention of front panels points up the final necessity. There must be some way for the computer to communicate with you, to receive your instructions and to give you its results, indicating the status of its calculations, and so on. Some people find a front panel adequate for these purposes, but most people prefer a more sophisticated device such as keyboard input with video or printed output. No matter what form it takes there must be some way for the computer to give you output.

Not in the bare necessity class, but highly desirable nonetheless, is some form of permanent storage that can be used to load preprepared programs and data into memory quickly. If you have to enter a long program by hand whenever you want to play a game, check on inventory, or otherwise use the computer, you won't use it much. It would be too much trouble — and the point of computers is to save trouble. Almost all home computer systems use *volatile* memory (memory which "forgets" everything when it is turned off). This can pose a severe problem. You'll want to consider including a permanent storage device in your system. Many alternatives are available, from inexpensive audio cassette recorders to magnetic disk drives of several sorts, and again, your personal needs will determine what is most suitable for you. When you start looking for any addition to your system, be sure that it is possible to use it with your particular computer. Interfaces for connecting a particular device are not available for every system, and a program to allow a particular computer to use a given device may also be hard to come by.

Now that you know what a minimal system involves, it's time to consider acquiring a system. The most fundamental decision concerns how you will build up your system. Do you want to build a computer from scratch, starting with integrated circuits and sockets and blank prototyping cards? Do you want to assemble a purchased kit? Or are you much more interested in *using* the computer and unwilling or unable to spend the time involved in

No one can deny the excitement of homebrew computing, the vast amount you can learn from designing and building your own . . . . But neither should anyone embark on homebrew computing without a thorough understanding of the risks . . .

construction? Let's consider these alternatives in more detail.

Homebrew

There is no better way to learn what goes on inside a computer than to build one yourself from scratch. Unfortunately, you have to know a great deal about it before you begin if you're to have much hope of success. Competence in the basic kit-building skills — soldering, wiring, and the like — is not enough. You must also have a thorough grasp of digital design, or be willing to spend months and dollars learning from your mistakes.

The hardest part of homebrewing a computer is troubleshooting. If you turn on the finished product and it doesn't work perfectly, you have no place to start to seek the problem. Is it a faulty component? Or just a careless wiring error? This sort of difficulty can drive you up the wall and result in your not having a working computer despite all your hours of labor.

Cost is another consideration. If you can trust your designs, parts, and wiring, you can build a homemade computer slightly less expensively than you can purchase one. But homebrew designs are notorious for the frequency with which they get changed during the building process — or a component could be damaged in the course of assembly, or a thousand other things could intervene to raise the price. For example, a necessary troubleshooting tool for homebrew computing is a good, triggered-sweep oscilloscope — an expensive investment, and one that requires some knowledge of electronics to use properly. The result is that most purely homebrew computers end up being *more* expensive than comparable purchased systems.

One approach to building your own, which eliminates some of these difficulties and risks, is to construct a computer using your own materials, but following a published design. Detailed designs that use a number of different microprocessor chips (integrated circuits) have been published in various magazines. If a design is from a reputable source and has been discussed in the magazines enough to find and remedy its weak points, you can embark on its construction with a reasonable hope of success. You're saved the trouble and expense of finding things out the hard way, but still derive the benefits of seeing every detail of its operation from the inside.

No one can deny the excitement of homebrew computing, the vast amount you can learn from designing and building your own, or the great sense of accomplishment that comes when you have a computer that is uniquely your own up and running. But neither should anyone embark on homebrew computing without a thorough understanding of the risks: it can be extremely expensive, extremely frustrating, and may *not* result in a working computer. Those with the knowledge and expertise to do so will find it an unparalleled pleasure, but those who don't have extensive knowledge and experience would be better advised to choose another route if they want the result to be a working computer.

The Kit

A very satisfactory way to combine the pleasures of building your own computer with the security of being able to anticipate a working end product is to build a kit. Kits are usually less expensive than comparable fully assembled computers, yet offer a better opportunity to develop a thorough understanding of how the computer works. If you have the required skills, this might be a way to learn about your computer's hardware firsthand. Which kit you choose, if you decide to take this approach, will depend primarily on two considerations. First, will the finished system suit your purposes? There is little point in building a kit only to have a finished computer that won't do your job well.

Second, and equally important, is there adequate support for the kit? How clear and detailed are the instructions? Has the kit been on the market long enough that most problems have been found and solved? Are there articles in the magazines which can help you know what you're buying or help solve difficulties you encounter? Does the manufacturer offer technical assistance and advice to kit builders? Do you know someone who owns one who can offer you advice? If, after considering the facts, you think you will have satisfactory instructions and a reliable source of information when you run into problems, the kit is probably a reasonable choice. On the other hand, if the in-

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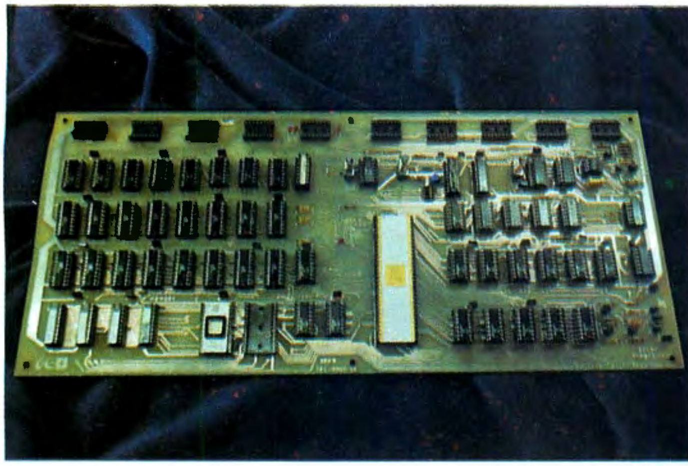
1 and 2 are examples of single board computers. The 16 bit Technico computer is shown at 1; and the KIM-1, which includes a hexadecimal keypad and display, is shown at 2. All-in-one computer systems include the Commodore PET, shown at 3; the Radio Shack TRS-80, at 4; the Apple II, at 5; and the Exidy Sorcerer, at 6.



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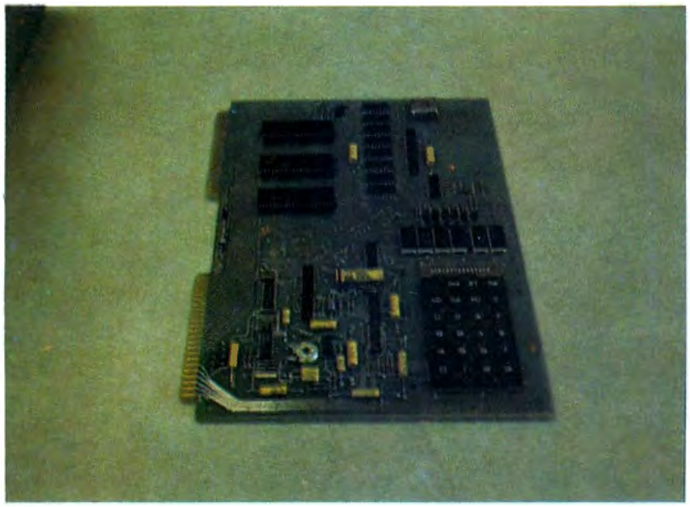

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3

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The person who benefits most from choosing to build a kit is the one interested in computer hardware. Not only does the kit provide a good way of learning about hardware design in general, but it also gives its builder specific information which will be needed to make other design projects for the system possible.

structions are inadequate, the support is weak, or the end product falls short of your needs, it probably isn't the kit for you.

Before embarking on kit building, it's wise to consider not only the adequacy of your tools (for example, some integrated circuits can be destroyed by too high a soldering temperature), but also to be sure you have an adequate — and adequately protected — place to work. If there are children in the house, you may have to find ways to protect the children from the computer and the computer from the children during the building process. Spilled liquids can wreak havoc with a computer, and a power supply, exposed and powered up for testing, can administer nasty shocks to the unwary. It all adds up to a general caution: think first; that way you can forestall any difficulties that might arise.

The person who benefits most from choosing to build a kit is the one interested in computer hardware. Not only does the kit provide a good way of learning about hardware design in general, but it also gives its builder specific information which will be needed to make other design projects for the system possible. If you're interested in interfacing various household devices (for example, a lawn sprinkler or burgler alarm) to the computer, building a kit will acquaint you with all the computer's requirements. Then, whether you design your own interfaces or adapt published circuits to your purpose, you'll be more confident that the interface will perform as desired.

Clearly, then, a kit can be a good choice for someone equipped to build it, especially if there is a need or a desire to understand the computer's operation fully. But what about the person who just wants to use the computer? A business, for example, usually needs the computer's capabilities, not a detailed understanding of its circuits, and the time required for assembly is just that much more delay before the computer can be put to use. For those who want to start using the computer immediately, a third alternative is available.

Since one can successfully write and run programs with only the vaguest notion of what goes on inside the computer, there is no reason people whose interests lie elsewhere should be forced to assemble the computer before using it.

The Fully Assembled Computer

A large percentage of those entering home computing are attracted not by any fascination with how a computer works but by the many uses to which computers can be put or by the fun of developing programs. Since one can successfully write and run programs with only the vaguest notion of what goes on inside the computer, there is no reason people whose interests lie elsewhere should be forced to assemble the computer before using it. For this reason, quite a number of manufacturers offer complete computers with no assembly required. You can buy a system, set it up, plug it in, and begin running programs immediately.

This is not the best solution for everyone, however, due to the higher cost — and, in some cases, limited repair service — of fully assembled computers. Without adequate repair service available, you can find yourself stranded without a computer for days, weeks, or months, since you may not receive enough information with the computer or have enough personal expertise to perform your own repairs. If you're buying the computer for entertainment, its disappearance to the factory for repair may be no more than a nuisance; but if you plan to rely on it in your business, excessive "down time" can be devastating. For this reason, it is wise to investigate the availability of repair service before purchasing a computer. Fortunately, microcomputers are among the most reliable devices of any kind on the market, so this is a common sense precaution rather than a necessity. But if you happen to get a computer with problems, it will be a precaution you'll be glad you took.

In one other regard fully assembled computers

Continued on page 78

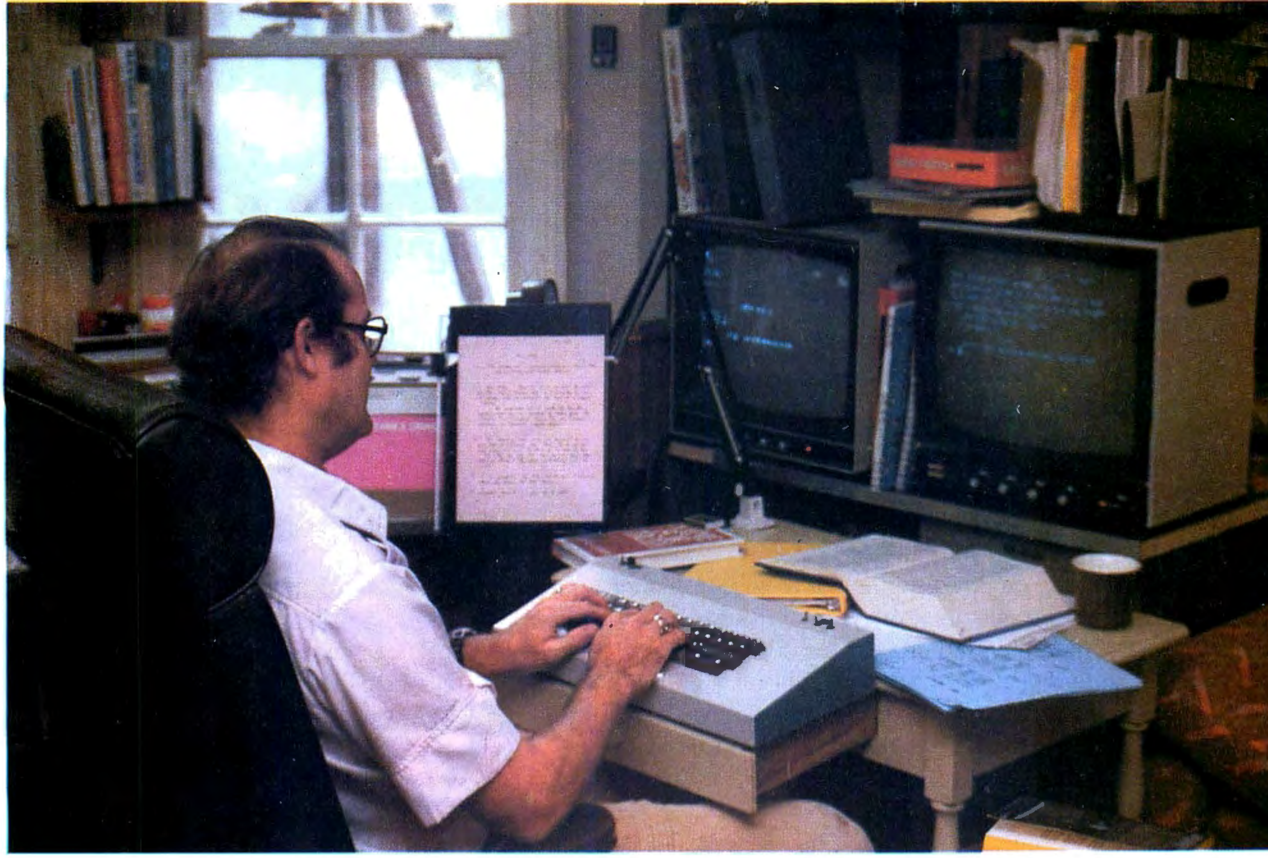
Photo by DE Mac Lean

Writing with a Microcomputer

by Jerry Pournelle

"Hey," said my mad friend Mac Lean. "I just got a microcomputer."

That was several years ago. Mac Lean has been involved in everything at one time or another: magic, rockhounding, organic chemistry, jewelry making; in his basement sit both offset and letter press, neither used for years after he learned the art of printing; in his attic sit unused professional sewing equipment, enough stagecraft gear to outfit a professional road company, amateur radio gear, and God alone knows what else.

So I paid little attention. A phase, a fad; certainly not anything to change *my* life.

After all, Marilyn Niven, my partner's wife, had an Altair which she played with from time to time, but Larry Niven never touched it except to play Star Trek and Hammurabi and the like. Home computers didn't *do* anything, they merely absorbed time.

Of course I knew that David Gerrold, a fellow science fiction writer, used a tape controlled Selectric typewriter to write books, and seemed inordinately happy with it; but when I watched him use it I didn't see what it would do for me. David, because of his involvement with *Star Trek*, has more correspondence to worry about than I do, and the system seemed better suited to that than to my needs.

A year passed, and two things happened at once. First, I got a very good offer for two books I had written 12 years ago; they were out of print and had reverted. The only problem was they needed some revisions. Not a lot, but revisions; every page, nearly every paragraph, needed a touch here, a lick there. It meant they'd have to be retyped from scratch, and to make it worse I didn't even have manuscripts of them any longer; I'd have to work from the printed editions.

Wouldn't it be marvelous, I mused, if those books were in some kind of electronically readable form so that I could do the scissors-and-paste job without so much retyping?

Secondly, Computer Power and Light (COM-

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I have no desire to experiment with computers. What I want is a reliable machine that does what I want it to do and which won't give me problems at 4 AM (my most productive hour).

PAL) advertised word processing systems for under $6000; and another friend, a systems engineer for a large computer company, sent me a copy of the COMPAL ad along with a letter he'd written on his own word processor (a program he did himself).

His program let you change character names, correct spelling, and all that . . . .

Computer Power and Light has a shop a mile from my house. I went by for a demonstration. It took half an hour to get used to the system. My only experiences with computers were from the dark ages: a visit to ILLIAC in the 1950s, and some programming in machine language for the IBM 650 in the late 1950s. When I was in the aerospace business computers were black boxes kept in the math sciences department. Programmers magically took your equations and brought you answers. I didn't even know what a control key was.

They showed me. The demonstration went so well that I almost bought the Computer Power and Light system on the spot. It was all so very marvelous: type on a screen, overstrike if you make a mistake, tell the machine the words you don't spell right and let it find them and fix them; incredible.

But what's the use of knowing experts if you don't consult them? I thought of my mad friend Mac Lean.

After a year he hadn't lost interest. Indeed, he spent more and more time with his computer, going for days without communicating to human beings. I had wondered why I hadn't seen him.

"We can build you something better," said he.

"But will it do what they showed me?" I asked.

"Sure. That's Electric Pencil. You can buy the program. In fact, there's a later version than you saw. What else do you want the machine to do?"

That, of course, is a key question; and for a rank amateur as I was, it's a hard one to answer. What can these machines do? I knew they could play games, but that was a negative feature: I don't need something else to take up my time.

"Taxes," I said. "An accounting system. Something to take care of my books."

"The machines can do it, but you may have to write the program," he warned.

Terrifying. But I had mental pictures of doing my writing on the machine, and after all, if they sold text editing programs, surely I could buy an accounting system. And the machines would speak BASIC and FORTRAN, I was assured; neither is a difficult language, they told me.

With BASIC and FORTRAN I could put my planet design equations (science fiction writers do have some special problems, it seems) and my solar system model and my rocket equations, all of which I then worked on my TI-59 calculator, right into the computer.

So I went through all the various things I thought I might want a computer to do. A short list, because, as mentioned, I didn't then know what they *can* do; but I thought it was quite a lot. Keeping track of my files and letters. Inventory of my library. Keeping track of contracts and contract due dates. I kept adding things to the list, expecting Mac Lean to tell me I'd asked for too much.

When I was finished, he said any good microcomputer could do all that. So now it was a question of which one. And there were lots of them. How do you choose?

First, we decided against any specialized system; there is a great deal of software floating around, some for sale, some public domain, but you have to have a general purpose system to use it. That wrote off DEC's PDP-8 based word processor, which would be great for text work but wouldn't do taxes and planet models. Next, because there is so much hardware available for it, we decided on the Z-80 processor and the Altair S-100 bus; perhaps not the most elegant and advanced system around, but reliable, and supported with vast quantities of software and hardware.

Jerry Pournelle, a former president of Science Fiction Writers of America, spent 15 years in the aerospace business before turning to writing full time. He is the former director of the Human Factors Laboratories for the Boeing Company, and was involved with projects Mercury, Gemini, and Apollo as well as military space systems.

Pournelle holds degrees in engineering, psychology, and political science, and was the successor to the late Willy Ley as science editor for Galaxy Science Fiction Magazine, *where his column "A Step Farther Out" was a popular feature.*

With Larry Niven, he is coauthor of the best selling novels Lucifer's Hammer *(Fawcett 1978) and* The Mote in God's Eye *(Pocket Books, 10th printing 1978). In addition, he has written a dozen novels of his own, including* The Mercenary, Birth of Fire, *and* West of Honor, *all published by Pocket Books, as well as a number of shorter works. He was the first winner of the John W Campbell memorial award.*

I was getting A COMPUTER: a machine with more power than the ILLIAC had back when I visited that monster, a machine that gave me more computing power than was available to the government a few years ago. And it would sit in my office and be all mine.

Finally I went to Proteus Engineering, a small firm run by Caltech graduate Tony Pietsch, and got an estimate of what the total system would cost. Throughout, my philosophy has been that I am not in the systems development business. I have no desire to experiment with computers. What I want is a reliable machine that does what I want it to do, and which won't give me problems at 4 AM (my most productive hour). Thus I consulted engineers who put it all together for me, and stand ready to maintain the system.

(Not that much maintenance has been needed; but we'll get to that.)

"Be warned," my advisors told me. "Things are not as they seem. You will have problems. And when the system does all you expect it to do now, you won't be satisfied, and you'll want it to *do more,* and that will cause more problems."

I didn't listen. I was getting A COMPUTER: a machine with more power than the ILLIAC had back when I visited that monster, a machine that gave me more computing power than was available to the government a few years ago. And it would sit in my office and be all mine. Incredible.

I wrote a check for a retainer.

System Description

The system they chose, with my not very informed consent, was a Cromemco Z-80 processor in the Cromemco "black brick" box. I paid Proteus Engineering the list price for assembled and tested gear. There was also a very reasonable systems integration fee. They bought the kits and built them, with their own modifications, such as a larger fan, and different connectors, and, I think, larger heat sinks.

There was considerable discussion of front panels. Like most amateurs, I rather fancied the idea of winking lights, and was hard to convince that they cause problems while solving none — unless you are interested in systems development, which I certainly am not. I was talked into the "black brick" and it has been enormously quiet and reliable; but I do miss the winking lights. Sigh.

The memory is four 16 K byte Industrial Microsystems memory boards. There is a Tarbell cassette board, a video display module and video input/output (I/O) board, and a serial I/O board. I also have two 15 inch video screens working through coax switches so that either board can connect to the video display module or I/O board as desired.

The disk system is the iCOM dual drive with 8 inch floppies. We had some discussion of this; from articles in various magazines I liked the voice coil type drive systems. Pietsch and Mac Lean pointed out that these were new; they might be excellent, but was I interested in being part of a quality control testing experiment? The big iCOMs are heavy enough to use as anchors, and we *know* they're reliable.

On that advice I chose the iCOMs, and certainly I have no complaints at all. I've never had a glitch from them. Once in a while I get an annoying squeak which iCOM says (they were very prompt in putting a knowledgeable engineer on the phone when I called) is harmless, a grounding spring, but it hasn't been bad enough to warrant opening the case and inserting a paper bushing as iCOM recommended.

There remained keyboards. I am used to a Selectric typewriter. I absolutely refuse to use a typewriter that puts the quotation marks up as a capital number; fiction writers use quotes *a lot.* There were, however, not many keyboards available with Selectric layout keytops. Since I was going to get a Diablo for hard copy output I could, of course, use its keyboard (as Computer Power and Light does for their under $6000 system) but the thing is enormous and there are paper feed problems if you let it sit on your desk.

We compromised. I tried a number of keyboards and ended up with a surplus Memorex, which Proetus converted to serial output. Now I can throw a switch and my keyboard has Teletype or Selectric layout as I choose. I never use the Teletype option, but a number of programming oriented visitors do. I made paper labels to cover the keytops and stuck them on with Scotch brand tape; amazingly they have held up for months, and 3M (Scotch) can have a testimonial on the ruggedness and clarity of their tape anytime.

For output we chose a Diablo 1620. I briefly considered a Spinwriter, but those were new and their reliability unknown, while businesses with Diablo told me their printers had never been out of service after several years; and a writer *must* have hard copy exactly on schedule.

The Diablo 1620 comes with a keyboard, which I thought I would have as a spare. That was a mis-

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Photo by Bill Watkins

take. I have never used the keyboard except to set margins, and the keyboard adds nearly a foot to the overall size of the already monstrous machine. Were I doing it over, I'd get a Diablo without keyboard to save space in my already overcrowded office.

That made up the basic system. With all equipment and fees it came to about $12,000; a bit more than I'd planned, but not excessively so. I waited anxiously for it. Meanwhile, I read Brown's *Instant Basic,* which is a marvelous book.

System Installed!

The system came with considerable software which was bought for me: Electric Pencil, FDOS III, and CP/M (with millions of programs from the CP/M User's Group), FORTRAN, and of course BASIC.

It also came with something special: Proteus Engineering's XMON. Of course I had no idea what a monitor does, why you need one, or what horrible problems you can have if you don't have a good one. Fortunately I'll never have to learn. Tony Pietsch's XMON does everything and does it quietly and unobtrusively.

It was only later, visiting others and watching their contortions, that I learned just how good XMON is. I can inspect and insert at any memory location, assign any combination of I/O devices to be either console or list — for example, the 80 character video I/O board and display can be the list device to let me test formats before actually printing on paper — and I can keep the disk directory and systems commands on one screen while writing text in Electric Pencil on the other. (Actually, XMON can support up to 26 I/O devices *and* 26 format drivers in any combination desired.)

Anyway: I had a computer! Could I write books on it?

Using the System

First I had to learn to use it: I was anxious to get the Electric Pencil running, but Mac Lean and Pietsch had me start with some BASIC programs. Keying them into the system and getting them to run taught me that computers are serious about syntax; there's a vast difference between a semicolon and a colon, and there's no proofreader in the editor's office to catch your goofs.

What I put up was a data base program. It had a convoluted logic, but it did run; the day it worked properly (about a week after I started) we broke out the champagne. Since then I've modified it into nonexistence, and learned something about kluges: don't use them. It's easier to start over. Now I'm stuck with variable names and types that don't make sense and slow down my program; fortunately I know enough to rebuild the blasted thing from scratch.

Next, Electric Pencil, the acid test for the system. Data base programs are fine and dandy, but Ezekial (don't all computers have names?) was intended to write books, not do work that I could hire a secretary for.

We got Electric Pencil working in an hour; I learned to use it in another. My playing about with BASIC programs taught me general principles about computer operation, but otherwise I was totally inexperienced. I kept hitting a carriage return at the end of each line. I forgot to hit line feed at the end of a paragraph.

I shouted. I screamed. I cursed the whole damned system, Hollerith and his ancestors, the unknown Greek who built the Anti-Kythera machine, the inventor of the transistor, and anyone else who had anything to do with loosing these monsters on an unsuspecting world. How could they do this to me? Was it part of some vast conspiracy?

But I was determined. I had too much money in it. Besides, I write science fiction. Other people use these machines. Are they more intelligent than I? Can I afford to admit that they are?

Back to work. No carriage return. Build each paragraph laboriously. Hit line feed with a shout of triumph when a paragraph is done. It's a slow way to write books, but I will master this monster.

But there were conveniences. Hit the wrong key, and you simply backspace and strike over it. True, Electric Pencil doesn't recognize the backspace key and you have to use shift delete, but surely you can learn something that simple. And there are all these other features: delete to end of line, delete paragraphs, insert letters and words, change names and spelling . . . .

In a couple of days came the realization: it worked. No more conscious effort, just use the machine.

A week later I tried to use my Selectric II typewriter. The next morning I moved it out to my secretary's desk. It was just too inconvenient.

In other words, I am hooked. The proof came when our agent asked for a screen treatment by the end of the week. Larry and I worked in our customary manner — sit down with lots of coffee and brandy and talk a lot — and I went back and banged the result into the machine. Took a copy to Larry. He came over with his comments. In one afternoon, four hours, we had incorporated his changes, produced a clean manuscript and gone over it, put in the rewrite, and got a final draft.

Another time we wrote a 15,000 word novelette in three days: three days from conception to final draft, incorporating all necessary changes.

That was the day Larry decided to try my machine. With no experience whatever he found himself typing in text. True, there was this problem with carriage return and line feed but those are trivial compared to being able to insert and rewrite and get clean copy.

And the next day he gave a deposit to Proteus Engineering. Now we'll have identical systems so we can trade disks.

Problems

There have been a few. First, Electric Pencil is fragile. It wants to accept various control characters. Much of this is due, I am sure, to the keyboard, which has a tendency to give off spurious control characters when too many keys are depressed at once; but some is due to the program itself, which seems unable to recover from goofs, and which is sold without a source so that the experts can't get in and modify it to fit my system and monitor.

It has other problems. When you reach the end of a line the text rearranges itself as it should, but it often drops characters: there is either no buffer, or the line buffer is too small. Without a source there's nothing to be done about it.

In fact, the lack of a source for Pencil is an irreparable difficulty. UCSD Pascal wants a 56 K byte system, which I could easily set up; except that Electric Pencil wants a video display module at hexadecimal CC00 and even after disassembly of Electric Pencil we found no simple way to modify the program so that we could relocate the video display module address. It would mean changing about 50 bytes of code. Electric Pencil has its own drivers and cannot talk to the monitor (in fact, going to the monitor can cause Electric Pencil to write over itself). The chap who designed the system doesn't answer telephone calls. It's frustrating because we would like to implement Pascal, and Electric Pencil is so written that I don't think

But glitches and all, this is so much faster than work on a typewriter that there's no comparison; I estimate that it saves me several months each year; months I can use for travel, or reading, or plain loafing.

there's any way to do it.

Solutions are forthcoming, however. One of my associates, the computer company executive who got me to COMPAL in the first place, has for fun built a word processor for the 6800 chip; he is being persuaded to write one in structured code for the Z-80. We'll have a full source on his, and it will talk to the monitor and use XMON's drivers.

Meanwhile, changing over to Digital Equipment Corp keyboards with true n-key rollover will get the spurious control characters out of the system. When we know exactly what we want for a word processor, we'll have keyboards built and keytops cut with dedicated commands built in; it's obviously easier to hit a key that says "insert line" than to press control and G simultaneously; and it will be easier to teach my secretary how to use it.

For that matter, there's software for sale all the time: if my associate doesn't get the text handler written in time, I'm sure someone will have one to sell complete with source so that the silly glitches (I'm typing fast now and Electric Pencil is dropping letters each time the line rearranges, and that is most annoying) can be cured.

There's another problem: to avoid my having to type in those reverted books that need revising, I want to have my assistant do it; but I have become so dependent on the machine that I need it most of the time, and John can't get at it. I have to find a relatively cheap system that can create Electric Pencil files (or those generated by the new word processor). I can put the simple box in the other room for my assistant's use. It needs no Diablo, and possibly I can make do with letting him save the text on tape, then read it into the master system and back out on disks. This, I freely admit, is a frill, but one worth having, and I'm looking into it now.

But glitches and all, this is so much faster than work on a typewriter that there's no comparison; I estimate that it saves me several months each year; months I can use for travel, or reading, or plain loafing.

Before I got the system, I could, in a good day,

turn out ten pages; I have done more, but not often.

The computer lets me turn out words at more than double that rate. It doesn't get in the way of writing: no paper to change, no erasures and strike-overs, no Sno-pake (I used to be an authority on Sno-pake, collecting vintage years); and best of all, every draft is a clean draft — but it's so easy to produce another clean draft that there's no hesitation over rewrite. (It's a common disease with writers: not wanting to mess up a clean draft. The mechanical work of writing is as discouraging as the creative effort.)

On my best day since Ezekial, I did ten pages an *hour* for several hours straight. Marvelous!

That's word processing. What else?

Planets and Taxes and Files

It was no trick to get my planet design and solar system and other scientific programs running. Most I did in BASIC because it's simpler to use (for me); but they're getting translated into FORTRAN because that's simpler to run and considerably quicker (once I fully understand the dreaded FORMAT and COMMON statements).

The troubles came with accounting and taxes.

Everyone advertises a general ledger program. Not one of the blooming things I've seen will work, or, if they do work, will produce anything an accountant would accept unless blind drunk.

For example, one company has a whole line of BASIC programs, each in a book for sale at a price of from $10 to $50. If you buy the expensive business system package they tell you (but not up front where you can see it) that not all the code to get the general ledger programs running is included in the book.

That's all right, though, because you wouldn't want what it produces anyway.

There are very expensive small business accounting systems which presumably work and work well; but if there's anything under $1000 that works and produces what an accountant would call books, I've yet to see it.

Most produce "special reports" that don't preserve any audit trail, and are no more than a glorified addition system.

So I had to write my own.

My journal and ledger program starts with MacKenzie's *Fundamentals of Accounting* and Meyer's *Accounting for Non-Accountants;* it is designed to produce journals that look like the journals in those books, and ledgers that look like the ledgers — and which have references to the journal entries.

It turned out to be a lot of hard work, but it was worth it. Moreover, it wasn't much more work than I would have put into doing my taxes — and once done, my taxes took only one day! I simply type in a chart of accounts (ledger page number, ledger page title, segregated so that 0-100 is assets, 101-200 is liabilities, 201-300 is capital, etc) and then use checkbook stubs and credit card receipts to make journal entries in the formats and manner advised by MacKenzie. I don't know any accounting, but the program prints out all the required information, and in the format recommended in the books. Another program posts all that into the ledger entries, a third closes the books and transfers the balances to a profit-and-loss account, and a fourth produces income statements. At all times the journal reference, date, check number (if check) and credit card type (if credit card), are carried with the entry so that even the ledger can be read; in that sense I think my program produces better information than the method recommended by MacKenzie or employed in the Wilmer Bookkeeping Set I used to use.

But whether better or not, it certainly preserves all the information, and it's no work to use. A journal entry consists of a check number (automatically entered if you like) and date; who to; what for; and a ledger page to be debited. The relevant checking account ledger page is automatically credited. When the journal is printed, both the ledger page numbers and ledger page titles are displayed, indented in the way accountants prefer, with the "who to" and "what for" entries shown as explanation — again in standard accounting format. This can now be posted (to say, Southern California Gas Company) and another program will summarize the ledger entries (posting pages 505, 507, 509 to "utilities," as an example) if you like; and it all happens fast and reliably, with sum of debits and credits checked at each stage, and other tests possible.

Enough enthusiasm for my own programs. I do admit a certain pride in my accounting system, although I wonder why no one else ever did it. My mad friend says it's because programmers are not accountants and accountants are not programmers. That's fine, but I'm neither. I merely pretend to know everything for a living. Mac Lean is also trying to persuade me to sell the business programs I've written, and I suppose I will if I can make it clear that I don't guarantee anything about them: they work for me, and they produce books that accountants understand, but they sure won't teach you to be an accountant, and I haven't the foggiest if they'll work on anything other than CP/M and Microsoft Disk BASIC.

The file handler works like a dream: two days to teach my assistant (who'd never seen a computer outside the movies) and another two days for him to enter all the files in the system. Now I can look

up any file by file title, subject category (data, contract, galley proof, etc) and *location.* We can find anything in minutes, even if it has been archived; and I can review the data files at any time.

The Bottom Line

Would I recommend my system to others? Obviously: I certainly didn't try to talk Larry Niven out of buying one, and he's both friend and partner. Frank Herbert has explored the idea, and so has Joe Haldeman; I expect it won't be long before lots of science fiction writers use computer word processors.

However, for the small business owner or writer (and full-time writers are small business owners whether they know it or not) there are problems. I solved the hairiest ones by having my system assembled, integrated, and maintained by an engineering consultation firm; I think I solved another by choosing Proteus and Tony Pietsch, since that got me XMON, and I suspect from watching other computer hackers sweat and swear at their equipment that I have perhaps the most sophisticated monitor known.

Example: in one of my accounting programs BASIC had the infuriating habit of inserting the word AUTO into a statement. I would edit the statement; rewrite it; and there would be that unwanted and unasked-for word. With XMON you can get to the monitor without dumping the job you're doing: it merely suspends the operation when you hit control backslash. I did so, and ran a nondestructive memory test; found that one memory cell was bad; returned to the job, saved the program (bad statement and all), went back to the monitor and ran a full memory check (both memory tests are part of XMON), and found precisely where the trouble was.

A midnight telephone call to Tony Pietsch got my system working again with minimum loss of time and effort.

XMON has allowed me to recover from a few of the glitches Electric Pencil is prone to; I don't know if I would be quite so happy with my system if XMON didn't make that easy.

I would also advise all those not utterly familiar with computing systems to do as I did: don't buy the very latest and possibly best, but stick to known reliable equipment. After all, you can write off the cost of the computer over a period of three years (or longer if you prefer); and I expect one day to upgrade and update — but only with hardware known to work. I am not in the systems development business, and have no desire ever to be.

But boy, has this thing made it easier to write science fiction.■

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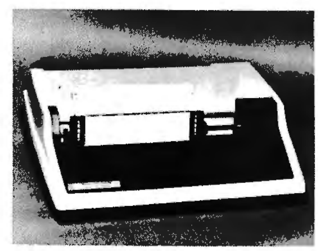

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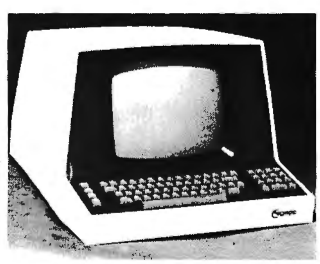

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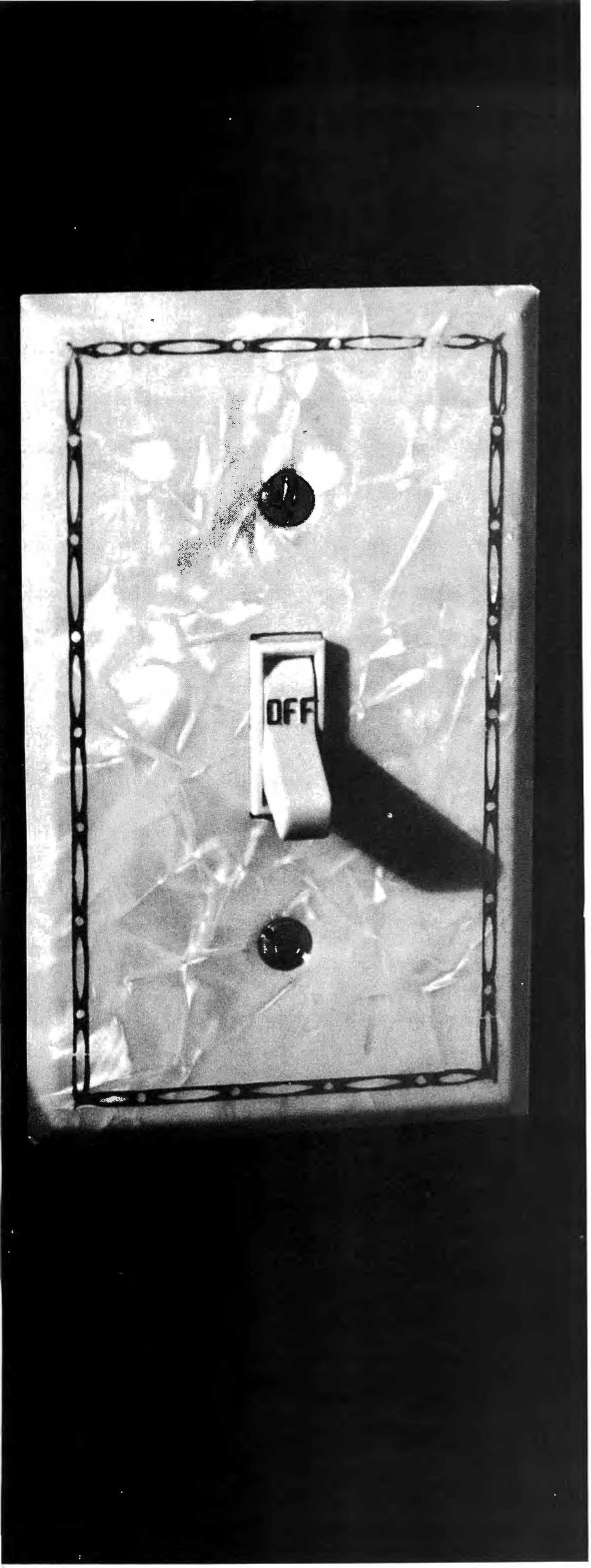

Photo by Ed Crabtree

The Binary World

by Russell Reiss

Everyone is familiar with binary devices. They are all around us: a light which is either on or off, a door that might be either open or closed.

When something can exist in only one of two states, there can be no ambiguity; the light is either on or off. This simple logical situation can be represented by a voltage (or current) which is in one of two corresponding states, such as high or low, positive or negative. One of the reasons digital computers are so reliable is that these two electrical states can be maintained with virtually no ambiguity even after extensive processing. Electronic digital computers are not the only type possible; fluidic, pneumatic, and mechanical digital computers have been built for special applications. However, electronic processing elements are very small, very fast, consume little power, do not wear out, and are inexpensive.

It is convenient to represent the two binary states numerically as 0 and 1. While it may seem natural to let 0 correspond to the light being off and 1 to the light being on, the opposite is also acceptable. Logicians would create a postulate, "the light is on," and then assign T (true) or F (false) based on the condition actually observed. Engineers deal with the 0 (F) and 1 (T) conditions as voltage levels, and say that they are using positive logic if the higher voltage state is

---

Russell Reiss has taught computer science and electrical engineering for over ten years. As president of General Digital Corp, he has also been responsible for the development of many microprocessor-based products.

When something can exist in only one of two states, there can be no ambiguity; the light is either on or off. This simple logical situation can be represented by a voltage (or current) which is in one of two corresponding states, such as high or low, positive or negative.

made to correspond to 1, or negative logic if the lower of the two voltage states corresponds to 1. Note that the actual voltages may be positive, negative, or a mixture; it is the correspondence between the two levels and the states of the actual event which determine whether positive or negative logic is the interpretation to use.

Computers obviously deal with quantities other than physical events. These include numbers, characters, and even abstract concepts. How can these be represented by just 0 and 1? This is accomplished by encoding all information to be processed by the computer, using only 0s and 1s. The binary coded decimal (BCD) code uses four binary digits (bits) to represent the decimal numbers 0 through 9 (see table 1).

Decimal	BCD	Evaluation in Decimal
0	0000	0+0+0+0=0
1	0001	0+0+0+1=1
2	0010	0+0+2+0=2
3	0011	0+0+2+1=3
4	0100	0+4+0+0=4
5	0101	0+4+0+1=5
6	0110	0+4+2+0=6
7	0111	0+4+2+1=7
8	1000	8+0+0+0=8
9	1001	8+0+0+1=9

Table 1: Comparison of decimal and binary coded decimal (BCD) representations.

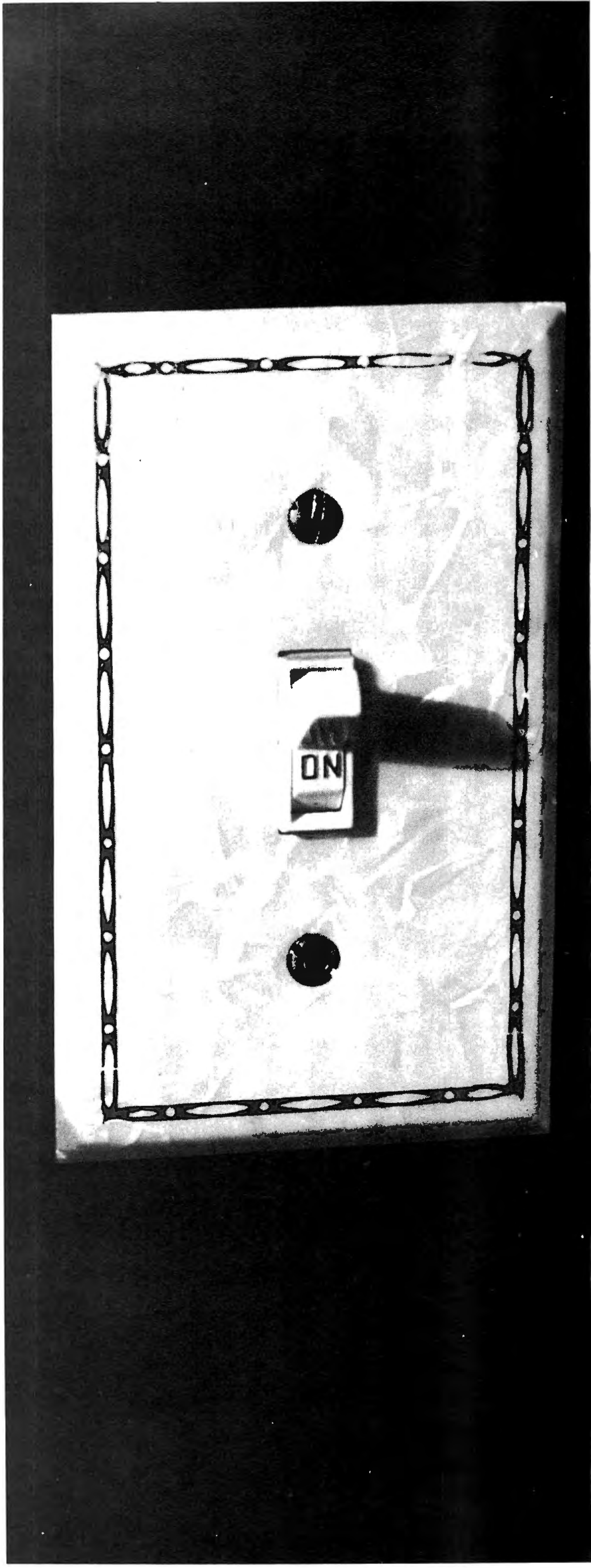

Photo by Ed Crabtree

Binary coded decimal is an example of a weighted code. In this case each bit has a weight which is an integer power of 2 (2^3, 2^2, 2^1, 2^1, 2^0). The number 5 may be evaluated by multiplying the value of each bit (0 or 1) by its weight, and adding these together.

$$\begin{aligned} 0101 \text{ (binary)} &= 0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 \\ &= 0+4+0+1 \\ &= 5 \text{ (decimal)} \end{aligned}$$

It can be seen that not all possible combinations of four bits are used in the BCD representations of 0 through 9. For example, the code 1101 is not used. The value of this code may be easily determined.

$$\begin{aligned} 1101 \text{ (binary)} &= 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 \\ &= 8+4+0+1 \\ &= 13 \text{ (decimal)} \end{aligned}$$

Four bits can be used to represent the numbers 0 through 15. By using more bits, each having a weight which is the next higher power of 2, we may represent as large a number as we wish by using a binary code. Since three bits can represent eight numbers (0 through 7) and four bits can represent 16 numbers, it is often convenient to group the bits three or four at a time and convert each group. The resulting *octal* or *hexadecimal* codes are much more compact and easier to remember than a long string of binary ones and zeros (see table 2).

Note that the hexadecimal code permits 16 values for each digit. Since we have only ten symbols in our conventional decimal number system the letters A through F are normally used. In this situation they are being used as *numeric symbols*, not as letters.

Binary	Decimal	Octal	Hexa-decimal
0000	0	00	0
0001	1	01	1
0010	2	02	2
0011	3	03	3
0100	4	04	4
0101	5	05	5
0110	6	06	6
0111	7	07	7
1000	8	10	8
1001	9	11	9
1010	10	12	A
1011	11	13	B
1100	12	14	C
1101	13	15	D
1110	14	16	E
1111	15	17	F

Table 2: Comparison of binary, decimal, octal and hexadecimal representations.

Decimal	BCD	Gray Code
0	0000	000
1	0001	001
2	0010	011
3	0011	010
4	0100	110
5	0101	111
6	0110	101
7	0111	100

Table 3: 0 through 7 in decimal, binary coded decimal and Gray code.

There are other codes for numbers in which the weights are not increasing integer powers of 2 (eg: the biquinary and Gray codes). These codes have special properties which are useful in certain situations.

Table 3 shows the numbers 0 through 7 in decimal, in binary coded decimal, and in Gray code. You can see that as we count from one number to the next using a Gray code only one bit changes at a time. This is not true for binary coded decimal. Since it is physically impossible for two bits to change at *exactly* the same time (one must always change before the other if you look closely enough) there could be confusion in some situations if a weighted binary code, such as binary coded decimal, were used. One classical example is a shaft angle encoder. This is a mechanical device that produces increasing numbers as a shaft is rotated through greater angles. If the shaft were slowly turned from the angle which produces a code of 3 to an angle which produces a code of 4, a binary encoding would result in a change from 011 to 100. All three bits are trying to change at the same time. Due to mechanical tolerances in the shaft encoder one bit will change before the others. If the rightmost bit happened to change first there would be a brief period during which the code 010 (2) is produced. Our computer would be told that the shaft is going backwards! There is no such problem with the Gray code.

Before letters, punctuation marks and other special symbols can be processed by computers, they must also be encoded as 0s and 1s. The most common code for this purpose is ASCII, which uses seven bits to represent up to 128 (2^7) symbols. This easily accommodates all upper and lower case letters, punctuation, symbols (such as $, !, #,

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Before letters, punctuation marks and other special symbols can be processed by computers, they must be encoded as 0s and 1s. The most common code for this purpose is ASCII, which uses seven bits to represent up to 128 symbols.

etc) with enough left over to provide for special control of devices such as terminals, printers and the like. Usually an eighth bit is tacked on to the ASCII code for error detection purposes. This "parity bit" is simply selected in such a manner that all characters have an even (even parity) or odd (odd parity) number of 1s in their codes. For example, the 7 bit ASCII code for the letter A is 1000001. The odd parity 8 bit ASCII code would be 11000001, which has three 1s. In most personal computers, this parity bit is simply ignored, being always set to either 0 or 1.

Through the proper use of encoding, all discrete information may be represented using only 0s and 1s, and, therefore, may be digitally processed. Analog (continuous) information may also be converted to binary form, but only approximately. We have seen how the angle of rotation of a shaft may be converted into 0s and 1s with a Gray code shaft encoder. The angle of the shaft is never known exactly, but a large enough number of bits can produce any desired resolution. Eight bits would provide 2^8, or 256, different codes as the shaft was rotated. This would permit us to know the angle to within $360°/256 = 1.40625°$. This resolution would be adequate in many applications.

The most common means of encoding analog information such as pressure, temperature, or speech, is to first convert the physical quantity into a voltage by using a suitable transducer, and then to apply this voltage to an analog to digital converter. The analog to digital converter outputs a binary code proportional to the applied voltage. By using suitable switching a single converter may be used with many transducers (see figure 1).

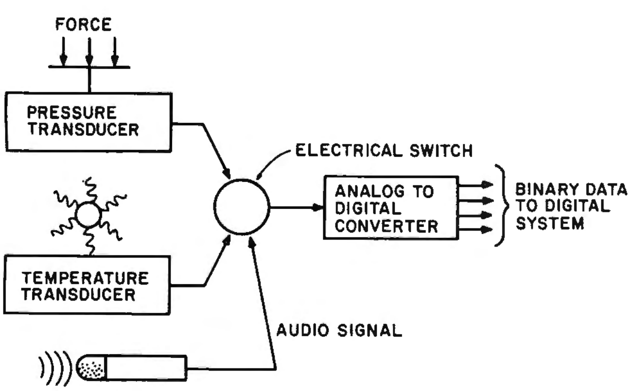


Figure 1: The use of switching to allow a single analog to digital converter to handle input from several transducers.

Now that we have all information in binary form we may consider the various operations which can be performed on this information. Certainly arithmetic operations can be done on binary numbers. They may be added, subtracted, multiplied, and divided just like decimal numbers. Just remember that the only possible symbols are 0 and 1. Thus 1 + 1 is not 2 since there is no symbol 2. It is 10 in binary, which (of course) has a *decimal equivalent* of 2. A review of the following examples, and a little practice, should convince you of the ease of binary arithmetic. In fact multiplication is pure simplicity since 0 times anything is 0 and 1 times anything is itself.

$$\begin{array}{r} 01101 \\ +00100 \\ \hline 10001 \end{array} \qquad \begin{array}{r} 01101 \\ -00110 \\ \hline 00111 \end{array}$$

$$\begin{array}{r} 101 \\ \times 010 \\ \hline 000 \\ 101 \\ 000 \\ \hline 01010 \end{array} \qquad \begin{array}{r} 11 \\ 11 \overline{)1010} \\ -11 \\ \hline 100 \\ -11 \\ \hline 001 \end{array} \quad \text{remainder}$$

While it may seem useless to perform arithmetic on certain kinds of binary information, for example ASCII character codes, this is not always true. The ASCII codes for letters are sequential. Therefore, the number of characters between C and Q may be computed by subtracting the code for C from the code for Q.

$$\begin{array}{rl} Q = & 1010001 \\ C = & \underline{1000011} \\ & 0001110 = 14 \text{ (decimal)} \end{array}$$

Two other considerations related to binary arithmetic are nonintegers and negative numbers. By inserting a radix point (analogous to a decimal point) noninteger binary numbers may be represented. The weights on these bits are negative powers of 2.

$$\begin{aligned} 101.101 &= 1x2^2 + 0x2^1 + 1x2^0 + 1x2^{-1} + 0x2^{-2} \\ &\quad + 1x2^{-3} \\ &= 4 + 0 + 1 + .5 + 0 + .125 \\ &= 5.625 \text{ (decimal)} \end{aligned}$$

There are a number of schemes for representing negative numbers, the most common technique is 2's complement notation. This is most easily explained by "synthetic subtraction." If the number −3 were added to +3 the result must be 0. Since we know what +3 and 0 look like in binary, we may synthesize −3.

Binary	**Decimal**
011	+3
+ ?	−3
000	0

The answer is that −3 must have the representation 101, since

$$\begin{array}{r} 011 \\ +101 \\ \hline 000 \end{array}$$

You may argue that there was a carry out the left side that got lost in this addition, and you are correct. However, we always have only some finite number of bits available to represent a number, 3 in this example, and we cannot worry about bits which fall into the proverbial "bit bucket." If you are not convinced that 101 is a good (3 bit) representation of −3 try adding it to 111 (decimal 7).

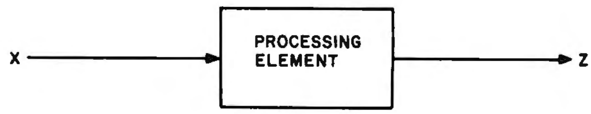
Binary	**Decimal**
111	7
+101	+(−3)
(1) 100	4

Again, a carry fell into the "bit bucket," but our 3 bit answer is correct. The same is true for any other 2's complement negative number so constructed.

You may also argue that 101 (binary) cannot be −3 since it is obviously +5. Again you are right (and wrong). Provided that we use enough bits in representing a number (four in this case) positive numbers will always have a leftmost 0 while negative numbers will have a leftmost 1. This permits us to keep them straight, but cuts the range of positive numbers in half to allow for negative numbers. A little practice will convince you that the technique actually does work.

Most people are familiar with arithmetic operations since they are also performed on decimal numbers. However, there are other (logical) operations which may be performed on binary numbers. These operations are the essence of computer operation. In fact, you will eventually see that even arithmetic is carried out by using these logical operations. In this case we are not concerned with the numeric value of a binary number, but only whether it is 0 or 1.

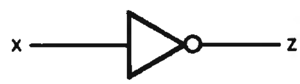
Let's take a short tour now through some of the internal "processing elements" which make up the design of any digital computer. Consider a processing element which has a single input and a single output.



Both x and z are binary and may only take on the values of 0 or 1. There are only two things which could happen to x as it is processed to become z. It may be passed through unchanged, in which case the processing element is a piece of wire. Or it may be inverted (complemented), in which case it comes out as 1 if it goes in as 0 and vice versa. If the latter case is true the processing element is called an inverter. This operation may be indicated in three ways: by a table, an equation, or a diagram.

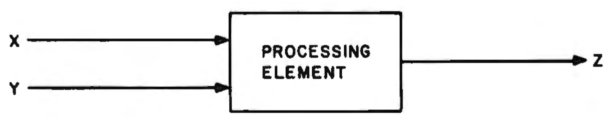
X	Z
0	1
1	0

$Z = \bar{X}$



These three representations all say exactly the same thing. The table gives the relation between every value of x and the corresponding value of z for this processing element. The equation says, "z equals x not." The diagram is simply the accepted digital logic symbol for an inverter, or NOT operation, which is defined by the table.

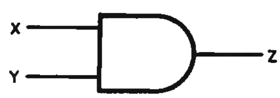
If two variables, x and y, are fed into a processing element (with one output, z) more things can happen.



There are 16 different processing elements which could exist in this situation. Two of these are uninteresting since they say that the output does not even depend on x or y but is a steady 0 or 1. Let's look at one of the other 14 processors.

X	Y	Z
0	0	0
0	1	0
1	0	0
1	1	1

$Z = X \cdot Y$

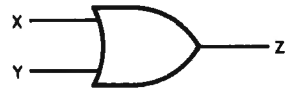


This is called an AND function since its truth table shows that z is 1 only if x is 1 AND y is 1. The value of z is 0 for the other three cases. The equation uses a dot to indicate AND. The diagram is the logic symbol for AND.

Another useful function is OR.

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	1

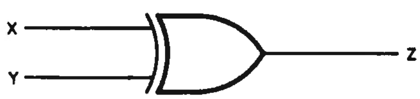
$Z = X + Y$



Here z is 1 if x is 1 OR if y is 1 (or if both are 1). The + sign is commonly used to indicate the OR operation, because of its similarities to addition.

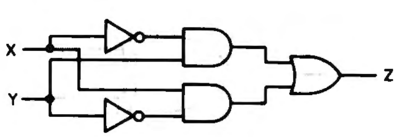
Although there are still 12 useful functions of two variables which have not been considered, logicians can easily prove that they may all be fabricated out of AND, OR, and NOT operations which translate into the basic electronic "gates" of computer hardware. Some of these functional elements are available as standard hardware gates while others are not. Consider the following:

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	0



In this case z is 1 if x is 1 OR if y is 1, *but not if both are 1.* This is called an EXCLUSIVE-OR (XOR) function since it is like an OR but excludes the case where both inputs are 1. The XOR is also an odd parity checker since it produces a 1 output only when an odd number of inputs are 1. This fact is particularly useful when we permit a large number of inputs. Although XOR gates may be purchased, they may also be "realized" as a combination of the universal set of elements AND, OR, and NOT. Notice that z is 1 in only two cases, when xy=01 or when xy=10. There is only one way for xy to be 01, x must be 0 AND y must be 1. Similar reasoning for the case xy = 10 leads us to:

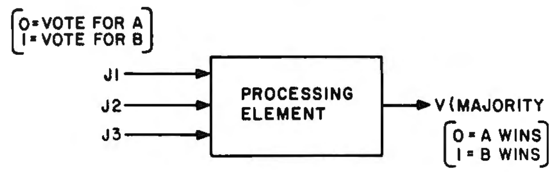
$Z = (\bar{X} \cdot Y) + (X \cdot \bar{Y})$



The equation calls out the two conditions under which z is 1. The diagram shows how AND, OR, and NOT gates may be interconnected to build an XOR processing element. The fact that both the equation and the diagram do implement the truth table may be verified by walking through the operations for all four cases given in the table and seeing that the proper value of z results.

Truth tables for any number of variables may be constructed. They will contain 2^N entries, where N is the number of inputs to the processing element. Since the desired output is specified for every condition of the inputs there can be no ambiguities. Let's see how a truth table is constructed.

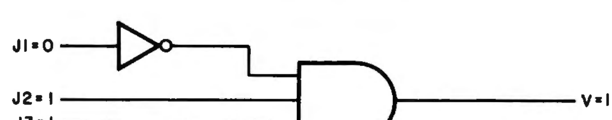
Suppose that there are three judges (let's call them J1, J2, J3) of a competition. Each judge may vote for either contestant A or contestant B. We wish to know which contestant receives the best two out of three votes. The vote of each judge is a binary event, and we may (arbitrarily) assign 0 to a vote for A, and 1 to a vote for B. The single outcome is the majority vote which we may encode as 0 for A wins, and 1 for B wins.



Since there are three judges there are three binary events and eight (2^3) possible cases. Our truth table will indicate the majority vote (output) for each of these eight cases (see table 4).

Notice that there are four cases in which A wins (output is 0) and four cases where B wins (output is 1). With three judges there can be no tie situations. The truth table always identifies what happens in every situation.

There are a number of techniques which logic designers use to translate truth tables into networks of AND, OR, and NOT gates. Some of these techniques result in less complex circuits than others. Our goal in this article is not to train logic designers and the interested reader may pursue a number of references, listed at the end of this article. Studying the truth table uncovers the fact that the output, V, is 1 in four cases. One of these cases is when J1=0 AND J2=1 AND J3=1. A 3 input AND gate could detect this occurrence if an inverter is used to convert the J1=0 event into a 1.

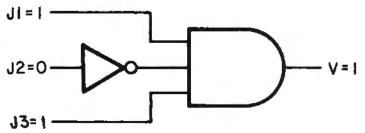


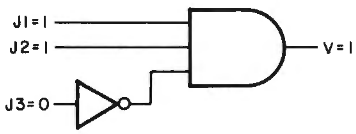
J1	J2	J3	V
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

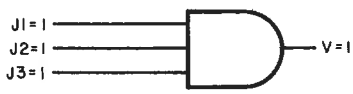
Table 4: A truth table which shows every possible outcome of the three judges example.

Since all three inputs to the AND gate are 1 in this case, its output will also be 1.

Similar AND functions may be constructed to detect the other three cases.







Since the final output, V, is 1 if the output of any of these detectors is 1, we may OR these together to complete the design (see figure 2). In this illustration we use a bar over the name of an input (say $\overline{J1}$) to indicate that it has been inverted but otherwise is the same signal.

We have never worried about the cases in which V is 0. This is quite acceptable since V will be 0 whenever it is not 1, and we have made it 1 everywhere it should be. If you worry about the 1s the 0s will take care of themselves, and conversely.

You might be wondering just how expensive the logic for such a voter circuit would be. Standard integrated circuits are available which contain in each package either six inverters, three 3 input ANDs, or two 4 input ORs. Although we must use a whole package even though only some of the gates in it are connected, the total cost of the four packages is under a dollar. To this you must add the cost of a printed circuit board which holds the components and provides interconnections, sockets, and a power supply. The cost of these items (at least $10) would completely mask the chip cost if they were not shared by other circuits within the system.

In order for this voter circuit to be used there must be means for entering the judges' votes (eg: switches) and providing an indication of the result (eg: lights). The exact form these interfaces will take depends on the application and the type of logic gates used.

Logic elements, as discussed here, are used throughout the modern small computer. Thousands of them are contained in the large scale integrated (LSI) circuits which comprise the central processing unit and interface chips. Other small scale logic devices are used for control and interaction between LSI devices. ■

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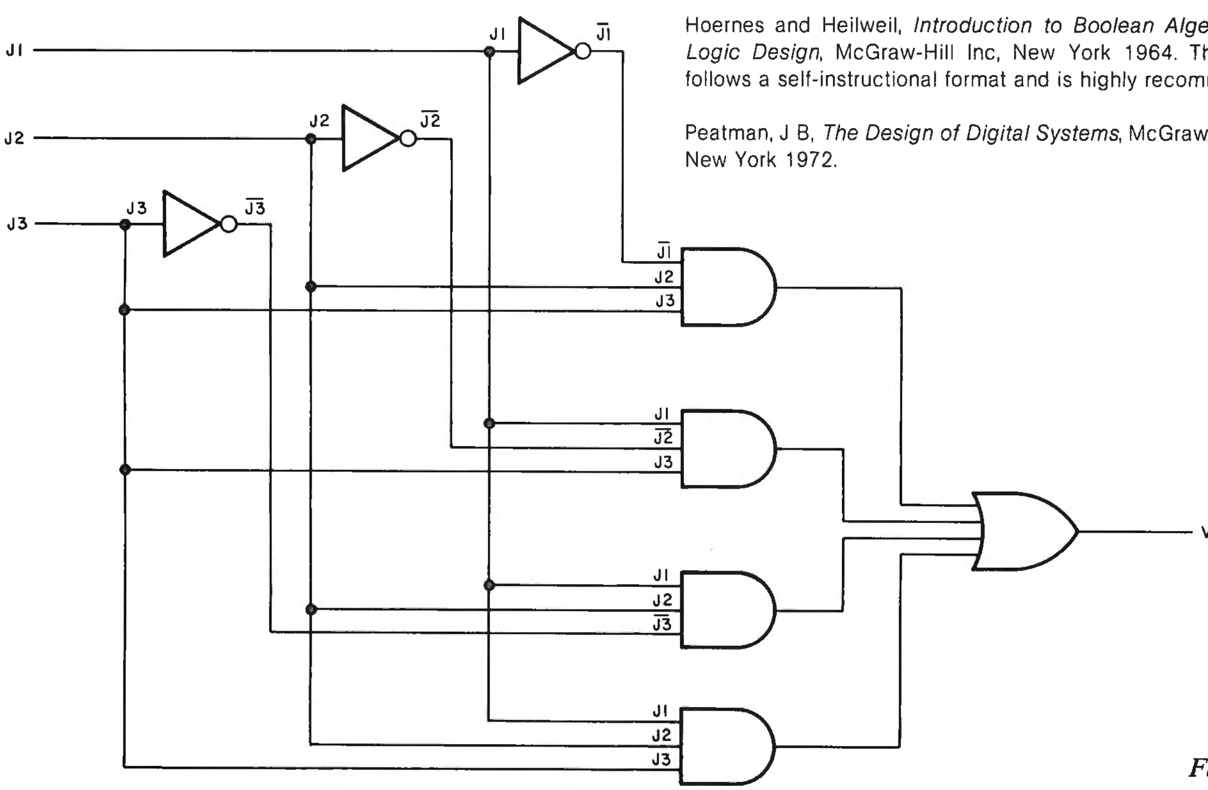

Figure 2.

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Photo by Ed Crabtree

A User Reviews the Apple II System

by Raymond G A Cote

Anyone looking for a personal computer should pay close attention to the Apple II system. It probably has everything you need to start with, plus room for later expansion. Let's look at what is delivered.

The item which most impressed me on unpacking my Apple II was the amount of documentation supplied. I feel that many system manufacturers do not give sufficient documentation of their product. This is not the case with Apple.

The main system comes with two well written manuals: the *Apple II Reference Manual* and the *Apple II BASIC Programming Manual.* The *Apple II Reference Manual* contains a quick but thorough synopsis of integer BASIC including use of high resolution graphics, saving data on cassette tape, and producing tones through the built-in speaker. Also covered are the system monitor commands, which tell the computer what to do; how to use the built-in disassembler to examine machine language operations in memory; assembly language listings of binary floating point routines; and a list of 6502 machine language operation codes. This is capped off with over 40 pages of hardware notes and diagrams of the Apple II system.

The person with a hardware background and the person who is familiar with BASIC will find this book very useful. However, it may seem rather cryptic to the first time user. Therefore, Apple also supplies the *Apple II BASIC Programming Manual.*

The programming manual is a thorough course on the use of the Apple II computer and the BASIC language. Chapter one teaches the user how to connect the Apple II system parts together and begin using them. The chapter discusses such things as connecting a video monitor and a cassette recorder, adding the provided game controls, and becoming familiar with the keyboard layout.

Integer BASIC is described and example programs are run to familiarize the user with the commands. I feel that this is the only way to learn a computer language. Reading a book is no substitute for working with example programs on the system. Be sure to try all of the programs in the book and experiment with them to determine how different commands affect the system.

After familiarizing yourself with the fundamentals of integer BASIC, you are ready to learn about some of the higher level functions. Apple II integer BASIC can work with strings and can also be used to gain access to machine level instructions. It may take a

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Ray Cote is editor in chief of BYTE magazine and the owner of an Apple II.

while to learn the intricacies of the language, but the *Apple II Programming Manual* will aid you along the way.

Apple II integer BASIC has one interesting debugging command which allows you to trace the flow of a program and another which allows you to display the value of specified variables. These commands are invaluable when trying to discover why a program is not executing as expected.

Integer BASIC also checks each line of code for correctness as it is entered into the computer. This alleviates many of the frustrations of entering a program and then having many syntax errors arise when the program is run.

Applesoft

Up to this point I have been talking about *integer* BASIC. This would probably lead most readers to believe there is another form of BASIC available, and indeed there is: floating point BASIC. Apple's version of floating point BASIC, called Applesoft, was written by Microsoft. Many computers use Microsoft BASIC, and it is good to have a language which can run programs from other machines.

Applesoft comes with its own manual. This manual is not designed as a self-learning text for BASIC. Apple suggests you become totally familiar with integer BASIC before working with Applesoft. Most of the commands learned in integer BASIC can also be used with Applesoft. However, I suggest you read over the entire *Applesoft Programming Manual* before writing any programs. Some of the commands have been revised, and it is tiresome to change all of the statements after keying in a program. (I found out the hard way in a relatively large program.)

The fundamental difference between Applesoft and integer BASIC is Applesoft's ability to work with decimal numbers instead of integer numbers. Applesoft also provides several other interesting capabilities. It allows the user to define 1 line arithmetic functions. I find this very useful. For example, there are several trigonometric functions not programmed into Applesoft which can be derived using the inverse tangent functions. By defining these trigonometric functions as BASIC functions, I need only write the name of the function instead of the entire definition each time I want to use it.

Although Applesoft does have a trace command, as does integer BASIC, it does not have the ability to display the value of a variable in debugging mode. Applesoft does have a very interesting program command which looks like:

ONERR GOTO *line number*

Photo by Ed Crabtree

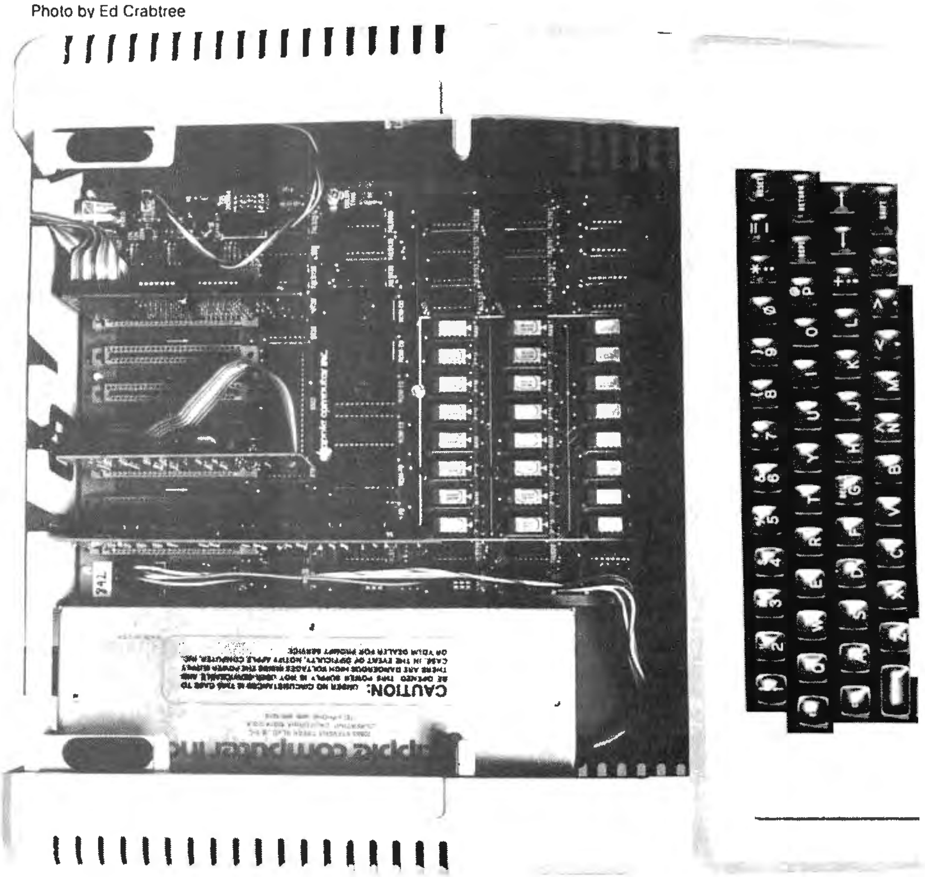


Photo 2: Inside the Apple II. The electronics are contained on a single board. The eight interface ports are arranged along the back of the board. Three interface boards are shown inserted. The floppy disk controller, shown in upper left with two ribbon cables, is capable of controlling two floppy disk drives. The middle board is an RS-232 communication port which I use with a modem. The long board in the bottom slot has onboard memory which contains Applesoft.

This statement allows a program to continue execution after an error has occurred. When any type of error occurs, the program goes to the line number defined in the command. That line is usually the start of an error handling routine which can repair the error and then resume normal execution.

This command helps the programmer write people-oriented programs. By checking what errors occur, you can compose error statements such as PLEASE INPUT NUMBERS ONLY, DO NOT USE LETTERS instead of SYNTAX ERROR, REENTER LINE. With the availability of this type of programming, programmers should work to make their programs as easy to use as possible and not have to rely on cryptic system generated error messages.

A set of appendices in the programming manual covers subjects such as starting Applesoft, editing programs, interpreting error messages, and the differences between Applesoft and integer BASIC.

Hardware

The Apple II system contains a single board 6502 computer in an injection-molded plastic case with a built-in keyboard. The case can withstand a fair amount of abuse, although I definitely recommend keeping food and beverages away from the system.

The 6502 single board computer is capable of holding up to 48 K bytes of programmable memory. Up to 16 K bytes of read only memory space are also available.

The Apple II also has eight input and output ports which are configured in an interesting manner (see photo 2). When an interface board is plugged in and addressed by the system, onboard memory is considered as part of the whole system. The peripheral interface boards which are supplied by Apple are known as *smart* peripherals, because each board comes equipped with a program contained in the onboard read only memory to control the particular peripheral it is designed for. This alleviates the problem of taking up more memory space with a program to run the peripheral. The user merely plugs in the peripheral board and it is ready to run.

The switching power supply seen at the bottom of photo 2 is capable of powering a fully loaded Apple II system with many added peripherals. Since it is a switching power supply, it is able to handle spurious power deviations. My supply has already survived several power drops without any difficulty, even though the television I am using as a monitor reacts strangely.

Peripherals

One of the first additions the serious user will want to make is a disk drive. Disk drives are considerably faster than magnetic tape, more reliable, and easier to use. Instead of waiting one or two minutes for a program to load, the disk drive can load it in a matter of seconds. A disk also provides the ability to store large amounts of data which can be randomly accessed. Anyone wanting to work with a lot of data will need a disk drive.

The disk drive supplied by Apple (shown in photo 3) is also a smart peripheral. The controller, which plugs into one of the peripheral slots, has an onboard program in read only memory that controls two disk drives. The controller can be seen in photo 2 plugged into a peripheral slot.

Apple also has smart parallel and serial interfaces which can be used to communicate with printers or other devices requiring high speed data transmission.

Looking at photo 2 again, the middle board plugged into the peripheral slots is a communication interface. I use the interface with a modem to communicate with other computers. Once again, the necessary control program is in read only memory on the board. The communication interface allows the computer to communicate over an RS-232 line at 300 or 110 bits per second.

The long board in the very bottom slot of the peripheral section in photo 2 is not really a peripheral, but actually contains floating point BASIC in read only memory. Applesoft can be bought in this form or as a program on cassette. Since I hate doing more work than I have to, I opted to have Applesoft available in memory at all times rather than reloading each time I needed it.

If you are interested in controlling household appliances with your computer, you may want the controller made by Mountain Hardware of Ben Lomond CA. This board plugs directly into your Apple II and allows you to control remote locations over the AC wiring already installed in your house. Wouldn't it be nice to have your computer turn on your lights, stereo, or the printer and video display?

Along more esoteric lines, the Speechlab voice input board allows you to talk to your computer. The board recognizes up to 32 words at one time. (Now if you can verbally tell your computer which light to turn on and off....)

Overall Opinion

The Apple II computer is a powerful device that can be expanded far beyond the basic unit. Both integer and floating point BASICs allow the user to work with low resolution graphics in 16 colors, and both have access to high resolution graphic capabilities. When you buy the Apple II you have a complete ready-to-run system and do not have to worry about assembly. Apple even supplies several demonstration programs so you can immediately see the capabilities of your system.

I do have several criticisms to make. My only complaint is illustrated in photo 2 at the upper righthand corner of the keyboard.

The Apple II computer is a powerful device which can be expanded far beyond the basic unit. Both integer and floating point BASICs allow the user to work with low resolution graphics in 16 colors; both have access to high resolution graphic capabilities.

There resides the reset key for the system, next to the equal key and the return key. I don't want to think about the one or two times I have accidentally hit this key and lost a program I was working on.

I also believe that computers should be made available to children. Therefore, a key which will reset the entire system should not be on the front of the keyboard where it is sure to be explored by an inquisitive child.

I mentioned earlier that Applesoft allows 1 line function definitions. I often have a need for functions which are longer than one line. The current function feature does not allow use of strings. I hope to see multilined function definitions and definitions using strings implemented in the future.

Although my power supply has survived minor power fluctuations, it does seem to have trouble when it gets below 60 degrees F. Make sure your Apple II is warm before turning it on, or you may damage the power supply.

I would like to see more documentation on assembly language along with a good assembler for the Apple. Although both versions of BASIC are very good, many time-dependent functions find that BASIC is too slow.

When you order your Apple II, determine what your video output system is going to be. If you are using a video monitor you will be able to connect the Apple directly to it. If you want to use a television (color if possible) you will need an RF (radio frequency) modulator. This can be obtained at your local computer store without difficulty. Make sure you order it when you order your Apple or you will have a computer without any means of producing video output.

Aside from the foregoing comments, I find the Apple to be a very useful computer system. Most of my problems have been cleared up by reading the manual more carefully. The rest of my problems were solved by the people of Computerland of Nashua NH, where I purchased the system.

The best way to decide if the Apple II is for you is to go to the nearest computer store and try it for yourself. I think you will be impressed. ■

Photo 3: A Disk II floppy disk drive. The controller plugs directly into the Apple II, and contains all programming needed to run the controller.

Photo by Ed Crabtree

A Review of the Commodore PET

by Blaise Liffick

Photo by Ed Crabtree

Photo 1: The PET (Personal Electronic Transactor) Model 2001 from Commodore Business Machines. The unit as shown is $795, including 8 K of programmable memory, a video display, graphics functions, screen editing, and a powerful BASIC interpreter contained in 14 K of read only memory.

I had the Commodore PET 2001 computer in my home for nearly two weeks recently, testing its reflexes, limitations, and strong points, and playing "crash the system": the usual things a professional systems analyst (or in my case, former systems analyst) likes to do with a new system. During that time I was often amazed, amused and frustrated, but certainly never bored. However, I can't help but feel a little schizophrenic about the PET. There are some things about it I like very much, and some I like not so much. The PET's Jekyll and Hyde personality shows weak and strong points in the most unusual areas.

Blaise Liffick is senior editor of BYTE Books.

The PET (Personal Electronic Transactor) Model 2001 is a very attractive machine (as shown in photo 1) with clean, compact lines. It is entirely self-contained in its fundamental configuration of a video screen mounted on top of the keyboard and cassette module. It is completely portable at 44 pounds, although its bulkiness makes it awkward to carry for long distances. Its overall dimensions are 16.5 inches wide, 18.5 inches deep, and 14 inches high. Power to all components is supplied through a single 115 VAC line, a definite improvement over the numerous power cords often associated with earlier microcomputer systems.

The only configuration available from Commodore at this time is the 8 K version of the PET, which includes a powerful Microsoft BASIC interpreter in 14 K of read only memory. This is the largest amount of memory that can be mounted in the PET without an expansion board. This basic unit costs $795, available either from the manufacturer or any of the dozens of PET distributors.

Commodore chose the 6502 processor for the PET as a result of Commodore's acquisition of MOS Technology a couple of years ago. While the casual user will probably use only the BASIC supplied with the unit, a more experienced user

I was often amazed, amused and frustrated, but certainly never bored.

will be able to take full advantage of assembly language programming.

Hardware

The PET video monitor is a 9 inch, black and white, high resolution video display. The display is arranged in a 25 line by 40 character array, and is also accessible by the BASIC PEEK and POKE commands. The display memory begins at location 32768. The built-in software provides for a blinking cursor, automatic scrolling, and full cursor control using left, right, up and down commands.

The keyboard of the PET (shown in photo 2) uses calculator style keys for all characters. They are arranged in the standard typewriter format for the most part, but are not staggered in rows and columns or spaced for touch typing. All of the numbers are arranged in a separate keypad to the right of the alphabetic keyboard in a true calculator format.

The standard PET character set includes the 64 alphabetic, numeric and special characters, 64 special graphic characters unique to the PET, and lower case alphabet, which is accessed by POKEing a 14 to address 59468 and using the shift key. In addition, all characters can be reversed on the screen (see photo 3) using the RVS key. This effectively doubles the character set of the PET.

The PET has some very special keys which are generally not available on a small microcomputer system. The RVS key was described above. There is also a RUN/STOP key. Unshifted (STOP) it acts as an interrupt to the execution of a BASIC program or listing. This is more commonly done with a BREAK or Control-C key. In the shifted mode (RUN), the system loads the next program from the cassette and automatically executes it.

Full cursor control is provided by four function keys. Two keys provide the up, down, left and right control of the cursor in shifted and unshifted positions. A CLR/HOME key sends the cursor to the top of the screen in the unshifted (HOME) position, and also clears the screen in the shifted (CLR) position. The INST/DEL key provides line editing by deleting characters from a line (DEL) and inserting spaces where needed (INST). These cursor control keys provide the PET with a nearly unique method of editing a listing, by directly editing the line instead of using text editor commands. Changing a line in a BASIC program, for instance, is consider-

PET's graphics are certainly one of its more impressive characteristics.

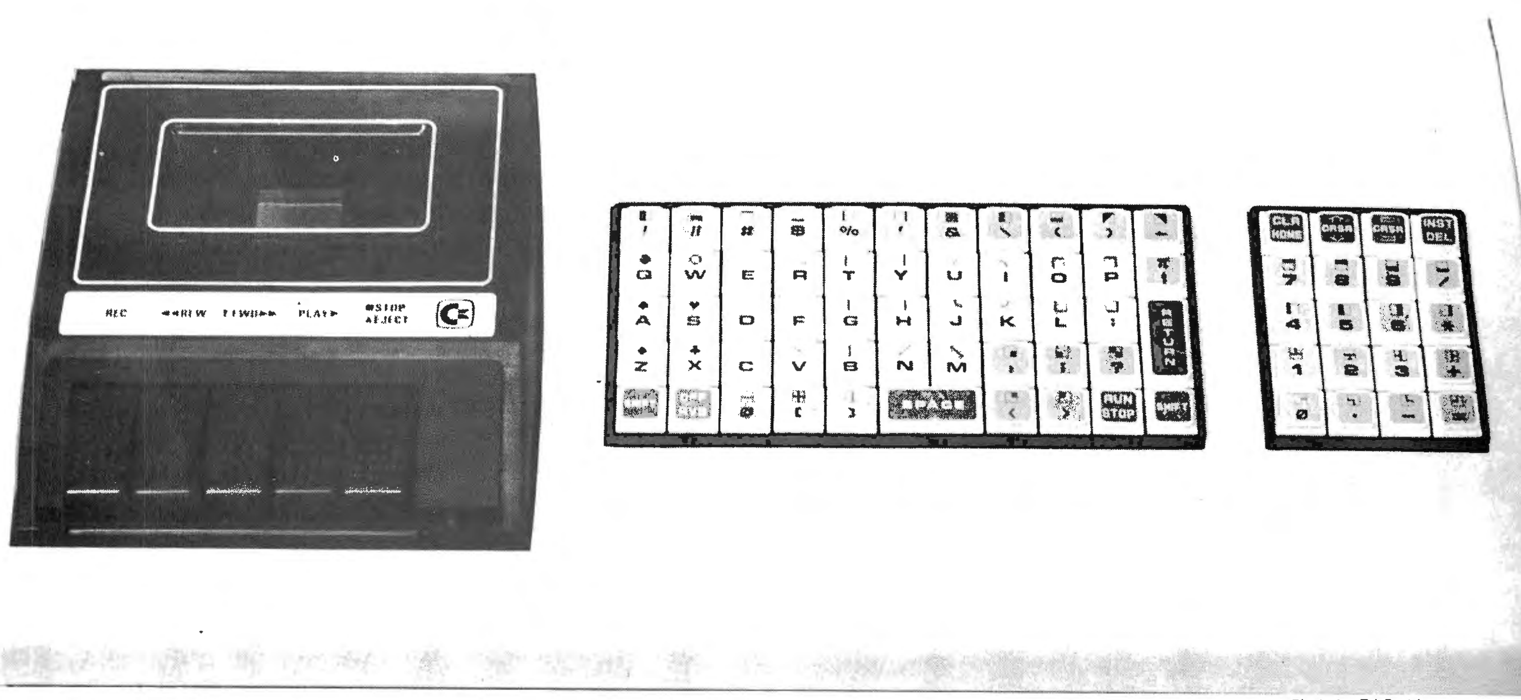


Photo by Ed Crabtree

Photo 2: A close-up of the keyboard configuration and built-in cassette drive. The format gives upper case characters, shifted graphics characters, and lower case characters when a POKE is done to location 59468 and the shift key is used. Note the special cursor control keys at the top of the numeric keypad at the right, the reverse video (RVS) key at the bottom left of the alphabetic keypad, and the RUN/STOP key at the bottom right of the keypad.

ably easier using the cursor control. This is shown in listings 1a, 1b, 1c, 1d and 1e.

Commodore even borrowed somewhat from its calculator line by including a function key that automatically provides π to eight decimal places.

PET's graphics are certainly one of its more impressive characteristics. Photo 4 shows the range of the graphic character set. The characters are arranged so they can be combined in nearly infinite variations to form any kind of figure desired. Although not especially useful for plotting mathematical functions, the characters provide the newcomer with easy access to the world of computer graphics.

The cassette drive of the PET is completely built-in (see photo 2). The controls are the standard cassette recorder controls minus the volume and tone controls — a wise move by Commodore. The most often heard complaint of users with cassette tape mass storage is that getting a tape to load involves too much trial and error, fiddling with the volume and tone controls. A similar complaint from PET owners is that a tape made on one PET machine may prove difficult to load on another PET. Apparently this problem arises because the volume and tone of the cassette machine provided with the PET are set at the factory and are sometimes not quite the same from machine to machine. The other annoyance is that a tape cannot be duplicated using the cassette machine in the PET unless each program is first loaded from the tape into memory and then saved onto another tape. Commodore's tape deck is both manually and software controllable.

Commodore provides for access to the world outside the PET via four edge connectors on the main board (see photo 5). These connectors provide an interface to a second cassette drive, an 8 bit programmable I/O (input/output) port, an interface port adhering to the IEEE 488-1975 standard (for more information on this standard, write to IEEE Service Center, 445 Hoes Ln, Piscataway NJ 08854, (201) 981-0060), and the microprocessor's address, data, and control buses. These connectors make adding peripheral devices and memory expansion modules to the PET much easier than on other microcomputer systems.

Software and Documentation

I was very disappointed that a small booklet called *An Introduction to Your New PET* is the only software documentation provided by Commodore. It is essentially a description of the special graphic and editing functions of the PET, and gives little insight into the operating system of the machine. At the end of the booklet is the list of all the commands supported by the PET, along with brief descriptions of the instructions. Unfortunately, if you are unfamiliar with personal computing (especially if this is your first exposure to BASIC), the manual may often be confusing. A background in engineering is also required in some instances to understand the particular command. For instance, the purpose of the CMD D command is given as, "Keep IEEE device D open to monitor bus."

In general, however, the BASIC software system is very powerful, providing for sophisticated graphics, string manipulation and mathematical programming. Assembly language programs can be executed both directly and under a BASIC program control. Finally, sophis-

Photo 3: The reverse video function. The print statement at the top shows that reverse video is set when the reverse R is shown in the line, and turned off when the reverse bar is shown.

Photo by Ed Crabtree

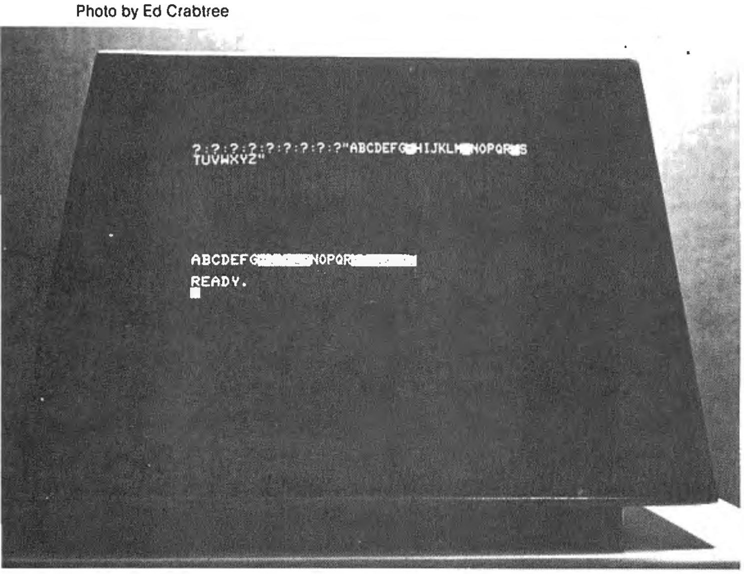
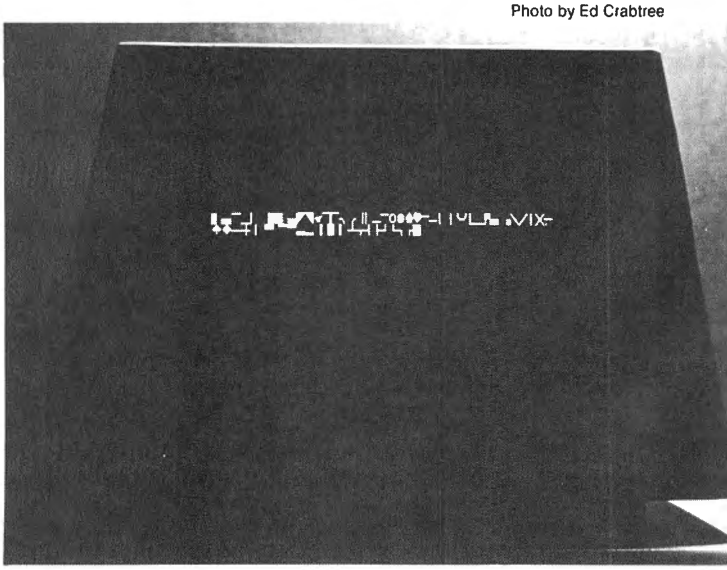


Photo 4: The range of graphic characters available on the PET, not including reverse video characters. These characters can be combined to make a wide variety of graphic figures.

Photo by Ed Crabtree



ticated input and output commands make this BASIC interpreter one of the more powerful systems available in an off-the-shelf microcomputer.

The only hardware documentation supplied with the PET is a small booklet called *PET Communication with the Outside World*, a supplement containing general background information on the PET interfaces described above. Without going into great detail, the four main interface ports are discussed, giving such information as the "contact identification characters, the connection for a standard IEEE connector, the IEEE mnemonics, and the signal definitions." As Commodore notes in its introduction to the manual, "this document is intended...for the experienced user..." For those newcomers to the field who want to add peripherals to the PET, I suggest contacting a local computer store or club for assistance.

Also, the operating system commands and operations for peripheral devices are given — a welcome addition. The software control of hardware outside the main device is usually not discussed in much detail in a company publication.

In the choice of commands to include in the system, Commodore again showed a unique approach. For instance, the TIME command gives the amount of time that has elapsed since the unit was turned on. This time function can be set to the time of day, so the user has access to an extremely accurate on-line clock. The WAIT command stops execution of a BASIC program until a certain condition is met. This can be used to synchronize I/O functions and to poll I/O ports for information. In connection with the cassette mass storage device, programs can be LOADed, SAVEd, and VERIFYed, all by program name. Table 1 gives a summary of the features of the BASIC on the PET.

Impressions

I said earlier that I get that

Listing 1a: An error has been made in line 30 (TEST is misspelled). The cursor (in this listing represented by an underscore) is shown following line 40.

```
10 REM THIS IS A TEST OF THE SCREEN EDITOR
20 FOR I=1 TO 10
30 PRINT "THIS IS A TIST"
40 NEXT I

_
```

Listing 1b: The cursor has been moved to the character after the mistake using the special cursor control keys of up *and* right.

```
10 REM THIS IS A TEST OF THE SCREEN EDITOR
20 FOR I=1 TO 10
30 PRINT "THIS IS A TIST"
40 NEXT I
```

Listing 1c: The incorrect character has been deleted and a space inserted to make room for the correct character using the delete *and* insert *keys.*

```
10 REM THIS IS A TEST OF THE SCREEN EDITOR
20 FOR I=1 TO 10
30 PRINT "THIS IS A T_ST"
40 NEXT I
```

Listing 1d: Line 30 shows the position of the cursor after the correction has been made. A carriage return at this point enters the correction.

```
10 REM THIS IS A TEST OF THE SCREEN EDITOR
20 FOR I=1 TO 10
30 PRINT "THIS IS A TEST"
40 NEXT I
```

Listing 1e: The correction has been made and the cursor returned to its original position using the left *and* down *cursor control keys.*

```
10 REM THIS IS A TEST OF THE SCREEN EDITOR
20 FOR I=1 TO 10
30 PRINT "THIS IS A TEST"
40 NEXT I

_
```

STATEMENTS:	Input and Output	Control	Definition	Execution Control
	READ	RUN	LET	GOTO
	DATA	CONT	DIM	IF . . . THEN
	RESTORE	NEW	REM	FOR . . . TO . . . STEP
	PRINT	LIST	DEF FN	NEXT
	INPUT	CLR		GOSUB
	GET			RETURN
				ON . . . GOTO
				ON . . . GOSUB
				STOP
				END

OPERATORS:	Arithmetic	Comparison	Logical
	=	=	AND
	+	< >	OR
	—	> =	NOT
	*	< =	
	/	>	
	↑	<	

BUILT-IN FUNCTIONS:	Arithmetic	Transcen-dental	String	Miscellaneous
	ABS	SIN	LEFT$	FRE
	INT	COS	RIGHT$	TAB
	RND	TAN	MID$	SPC
	SGN	ATN	CHR$	POS
		LOG	ASC	TI
		EXP	LEN	TI$
			VAL	ST
			STR$	

OTHER FEATURES:	Tape Operations	File Operations	Miscellaneous
	SAVE	OPEN	PEEK
	LOAD	CLOSE	POKE
	VERIFY	PRINT #	USR
		INPUT #	SYS
		GET #	WAIT
			CMD

DATA TYPES: Real numbers (eg: A), integers (A%) and strings (A$) of up to 73 characters.

ARRAYS: Any number of arrays of reals, integers or strings with any number of dimensions.

PRECISION: Ten significant digits for real numbers.

SPEED: Executes the loop 10 FOR I = 1 TO 10000:20 NEXT I in about 15 seconds.

Table 1: A summary of the features of the powerful PET floating point BASIC, written for Commodore by Microsoft.

Summer 1979 © onComputing Inc

. . . with the possible exception of the keyboard, the design of the machine is well thought out.

Jekyll and Hyde feeling in regard to the PET. Even Commodore seems a bit confused.

In the year since the PET has been available, Commodore has apparently not been able to supply much in the way of support peripherals — not even a memory expansion module. This area has been left entirely to independent manufacturers. Commodore uses the IEEE 488 interface bus, an industry standard, almost as if intending other companies to supply the second cassette drives, printers, floppy disk systems, etc, which are now available for the PET. Interestingly, though, Commodore has been working on its own printer for more than a year.

Although Commodore intended the PET to be a front runner in personal computing, the use of the calculator style keyboard instead of a typewriter style is perplexing. This choice means that manual entering of programs is both difficult and time consuming.

In the area of software, Commodore has again chosen to let other companies supply any system software or application programs. The only software it supplies is an assembly language monitor — all this in spite of the fact that Commodore is soliciting programs to distribute via an announcement and address in the programming manual.

Finally, the lack of appropriate documentation is somewhat frustrating. For a product supposedly aimed at the education field and at newcomers to the microcomputing field, the PET is sadly lacking in support. Since Commodore had gone to the trouble of making interface information available to "experienced" users, you'd think the hardware documentation could have included at least a general system schematic.

I can't help but feel ambivalent about the PET when you stack up the above against all the strong points in its favor. For instance, with the possible exception of the keyboard, the design of the machine is well thought out. I/O (input/output) ports were thoughtfully provided in a format which is easy to interface. Expansion of available programmable memory is already possible. The graphics capabilities of the PET are certainly an outstanding attribute. And the level of BASIC used shows that Commodore understands the frustrations of programming in BASIC. Also, Commodore delivers PETs on a regular schedule, and there is no doubting the overall quality of the system.

There are definitely some things I'd like to see happen with the PET. But most of these things are already being taken care of by companies other than Commodore. For instance, a full-size typewriter keyboard is available from several sources. Floppy disk systems are also available. And software for the PET, both systems and applications, is becoming plentiful.

So, all in all, the PET is a viable system for any home computer user, whether beginner or experienced experimenter. Just remember that the initial $795 for the PET, as with nearly all other personal computer systems, is not the final expense. ■

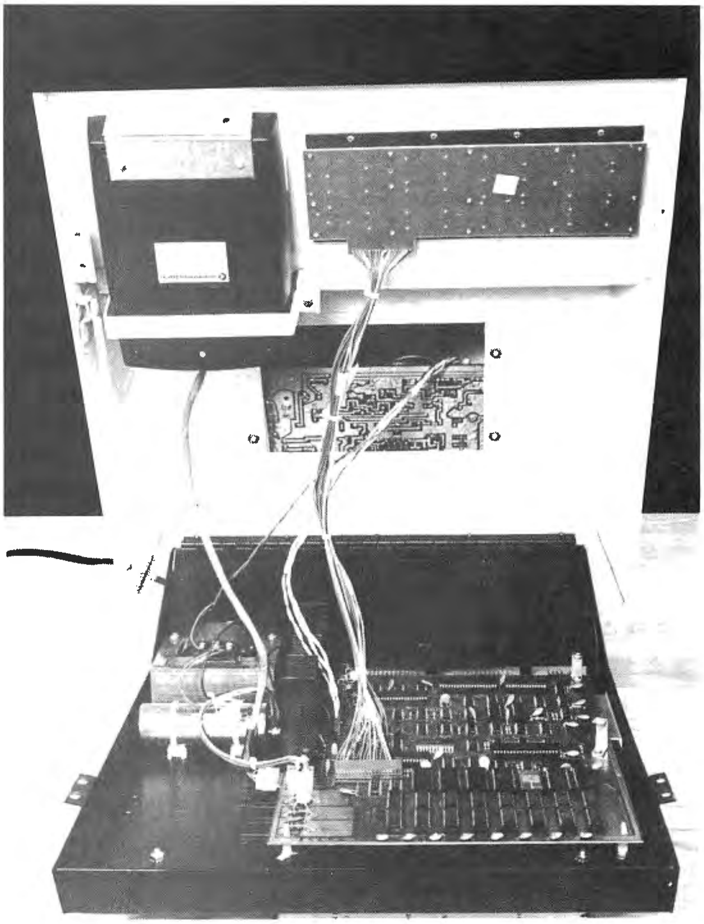


Photo 5: Internal structure of the PET. The main board with the 6502 mirco-processor, main memory, and I/O edge connectors is shown at the bottom right. The video display board is shown at the center of the picture, and the back of the cassette drive and keyboard are at the top of the photo.

Photos courtesy of Exidy

Photo 1: The Sorcerer resides completely within the keyboard enclosure. With a video monitor and one or two tape drives plugged into the back panel, the machine becomes a complete personal computer system. Higher level languages and application programs in read only memory plug into the right side of the enclosure, and can be changed in seconds.

A User Reports on the Sorcerer Computer

by Ken Barbier

The Sorcerer computer from Exidy Inc represents the second generation of self-contained personal computers aimed at the user rather than the hobbyist or experimenter. By not participating in the mad race to market characterized by the first generation, Exidy was able to take the time to perfect the machine and avoid some of the design and marketing errors of their predecessors. The result is suitable for instant use as a serious home or business computer, and includes features making it readily useable as a stand alone industrial controller or remote terminal.

The Sorcerer is priced at $895 and includes a Z-80 processor, 8 K bytes of user workspace programmable memory, an 8 K version of Microsoft BASIC language in a removable Rom Pac, and an exceptionally complete 4 K monitor and input-output control system in an on board read only memory. Standard features include two audio tape interfaces with motor on-off controls, an RS-232 serial input/output (I/O) port, an 8 bit parallel I/O port with handshaking controls, and a 50 pin edge connector allowing expansion of the processor bus.

The on board programmable memory can be expanded to 32 K bytes, and an expansion chassis is available which attaches to the 50 pin connector and accepts S-100 bus devices.

Special features of the Sorcerer include a set of graphics characters accessible from the keyboard which can be linked together to form line drawings. The graphics character keycodes can be input to a BASIC language program as string variable characters, allowing BASIC programs to draw background forms, for example.

The most unique feature of the Exidy machine is the use of a Rom Pac cartridge, which is an adaptation of an 8 track tape cartridge, containing a printed circuit board with sockets for up to four read only memories or erasable read only memories. The BASIC language Rom Pac can be unplugged and an optional assembler/editor or word processing Rom Pac inserted. For the person who is willing to learn about the necessary details, Exidy makes available blank Rom Pacs which can be set up with jumper wires to accept the standard 2708, 2716 or 2732 read only memory parts. The blank Rom Pacs cost $49 apiece and can provide up to 16 K bytes of instantly interchangeable application program. In order to use this facility, though, the owner of the Exidy would need another computer which has a software development system including an assembler program, as well as the hardware needed to put patterns *in* the read only memory parts. No 2708/2716/2732 programmer unit is presently available from Exidy, although the optional assembler/editor Rom Pac would allow the Sorcerer to create the programs for this application. A single 2708

would be more than sufficient to configure the Sorcerer as a remote terminal. At power up, the monitor program erases the screen, homes the cursor, and jumps to the Rom Pac program, if one is installed. This makes the machine suitable for use as a dedicated controller, as no operator intervention need be necessary following a power failure and restart.

The Sorcerer computer is a rugged package which has already proved its ability to withstand repeated trips in the trunk of a car. I have given the machine a real test under fire, moving it between demonstration sites without trouble. The keyboard has an excellent feel, which is not always the case with inexpensive keyboards. Future applications planned for the Sorcerer are as a small business data processing system and as a cost effective substitute for dedicated controllers.

The basic computer does not include a video monitor or casette tape deck, so the addition of these would bring the base price to around $1100 for a fully capable personal computer. While this price can be beaten by the competition, the special features of the Exidy computer make it the wisest choice for the more serious microcomputer user. ■

Ken Barbier is self-employed as a writer and consultant, specializing in developing both the hardware and software necessary at the interface between the computer and the real world. He draws upon 25 years experience in electronics, including two decades of intimacy with digital logic systems. His first exposure to programming was in using assembly language on a PDP-8 in 1966. His last ten years have been devoted almost exclusively to the analysis, design, and programming of data acquisition and control systems for radio astronomy, working on systems for the University of Maryland, the National Radio Astronomy Observatory, and Jet Propulsion Laboratory.

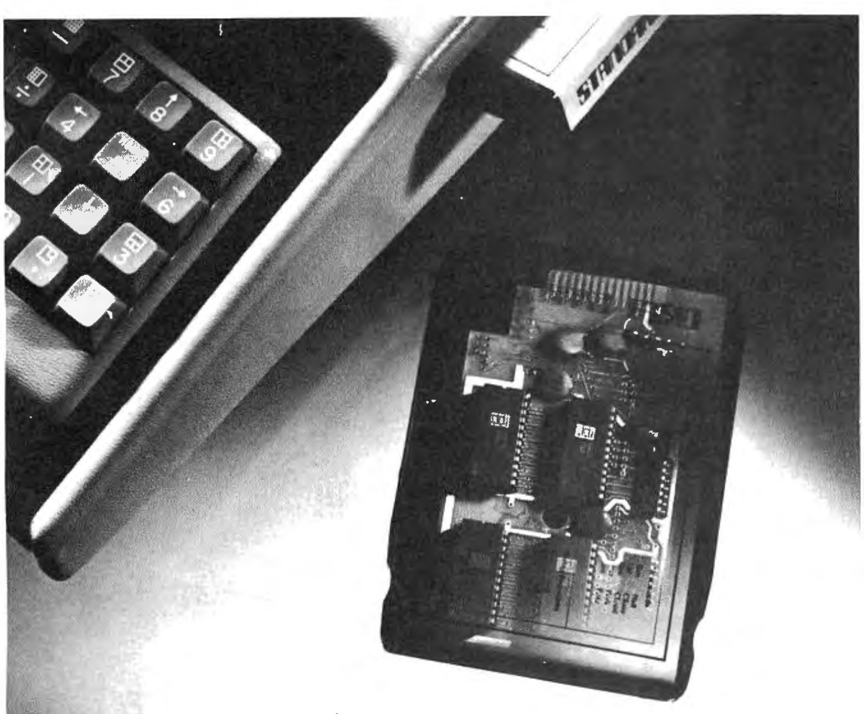


Photo 2: An "X-ray" view of the Rom Pac cartridge. Up to 16 K of user programmed erasable read only memory can fit within a single optional Rom Pac. The standard Sorcerer comes complete with 8 K BASIC in a Rom Pac.

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A User Reviews the Radio Shack TRS-80

by Richard Shuford

It is difficult *not* to know at least something about the Radio Shack TRS-80 microcomputer system. Television, magazines, newspapers, and direct mail are the advertising media used by the Tandy Corp for its promotion. I'll repeat some of the information you may have gleaned from the advertising here, and then attempt to present some facts that are less widely known.

The simplest TRS-80 system consists of a keyboard and processor unit, a power supply, a video monitor, and a cassette recorder. Photo 1 shows these devices set up in a working configuration. Other accessory devices (peripherals) are available. Floppy disk drives, printers, telecommunication adapters (modems), and even a voice synthesizer are being sold by Radio Shack for use with the TRS-80. Other manufacturers are also marketing peripherals for the TRS-80.

Processor Options

The keyboard and processor unit is sold in four different versions. There is a choice between two

Richard Shuford is an editor of BYTE *magazine.*

Photo 1: Radio Shack TRS-80: keyboard and processor unit, video monitor, power supply, and cassette recorder.

different BASIC interpreters, and another choice between two different sizes of programmable memory. The two BASIC interpreters are designated Level I and Level II. The programmable user memory may be 4 K bytes or 16 K bytes in size.

Computer Languages

Unfortunately, it is not possible to tell current computers what to do using the English language (or Swahili or Russian, for that matter). Human languages contain ambiguity. Computers have no sense of context to guide them, and could misinterpret what we might tell them in our human language. (Have you noticed that a fat chance and a slim chance are the same thing?)

Talking to the computer in its native tongue is not practical for most people either. Since a typical computer statement usually looks something like 11000011011110100010000, we resort to the crafty method of teaching the computer to understand a language logical enough so that it doesn't confuse the computer, and yet one which people may learn without too much trouble. For many users of computers, BASIC is a suitable compromise language.

Radio Shack has made available two different variations of the BASIC language for the TRS-80. Each is contained in a permanent read only memory. When you turn the computer on, the BASIC system is automatically activated. This is a convenience, and an improvement over the very first microcomputers, with which the process of getting BASIC running was tedious and time consuming.

Level I BASIC

The less expensive version of BASIC is Level I. It is loosely based on Palo Alto Tiny BASIC, written by Li-Chen Wang. Unlike Tiny BASIC, it has floating point arithmetic, but it lacks many features of more advanced BASICs. Its floating point feature allows a program to deal with numbers over a wide range of values. It should be noted, however, that like all BASICs, it maintains a limited number of digits of accuracy (about six or seven decimal digits). If you tried to add the amount 300100.4 to the amount 1.10005, the sum that the computer would report is 300101.5, not the correct 300101.50005.

... uses for the Level 1 BASIC interpreter are in teaching computer concepts and programming...

The ability of Level I to handle data not made up of numbers is extremely limited. Two string variables (A$ and B$) are provided, but they may be used only in input and output statements. Another limitation of Level I is its rather simplistic way of handling arrays. The Level I interpreter recognizes just one array, which it calls A. If a program needs to store several different kinds of data in an array, it must all be stuffed into the A array, and the poor programmer has to keep track of it.

The most likely uses for the Level I BASIC interpreter are in teaching computer concepts and programming, and in computer games of relatively limited scope.

Level II BASIC

For about $100 additional charge, the TRS-80 owner can buy the Level II BASIC language interpreter, which has the capability to do much more than the Level I system. Level II BASIC was developed for Radio Shack by Microsoft. Microsoft has written BASIC interpreters for many other microcomputer manufacturers, including Commodore (PET), Apple Computer Co, Ohio Scientific, Cromemco, and Rockwell. All these different BASICs are relatively compatible, except for certain machine-specific features. Microsoft BASIC was inspired by BASIC-Plus, as used by Digital Equipment Corp on its PDP-11 minicomputers.

A complete description of the features of Level II BASIC is not possible here, but some of the major ones are as follows: a relatively versatile editing system, to allow easy modification of a program; a facility for multiple arrays; statements and functions to manipulate nonnumeric character data; statements to use peripheral devices; mathematical functions; double precision arithmetic; and powerful abilities for the advanced programmer. Suffice it to say that users who wish to do any kind of serious work with the TRS-80 will want the Level II BASIC.

About a year ago there were long delays in delivery of Level II machines. The situation has improved greatly since then; some Radio Shack stores now have Level II machines in stock. Radio Shack will upgrade a TRS-80 from Level I to Level II by replacing the read only memory integrated circuits. Installation is included in the price of the new integrated circuits.

Not long ago I was able to watch a Radio Shack employee install a Level II kit in a TRS-80. He removed the integrated circuits containing the Level I interpreter and plugged a connector attached to a ribbon cable into the just vacated socket. At the other end of the ribbon cable was a small printed circuit board with four integrated circuits on it. He attached the small new board to the etched side of the main processor circuit board, and then attached the ends of each of four small wires leading from the small board to selected points on the main board.

He proceeded to change several jumper connections which inform the main processor exactly what to do to start the BASIC system. He

used a sharp tool to cut several connections on the main printed board, and, lastly, changed a capacitor on the main board. The necessity of making all these changes seems to indicate that Level II BASIC was an afterthought. It is fortunate that the designers of the TRS-80 eventually thought of developing Level II BASIC. It is extremely difficult to do anything practical without the more advanced interpreter. Photos 2 and 3 point out the location of the Level II additions.

Memory Sizes

Two amounts of programmable memory are available: 4 K and 16 K bytes. In the computer world, the capital letter K means "times 1024," and a byte is the amount of memory which stores one character. The BASIC system uses about 400 bytes for its own purposes, and the user cannot store any program text or data in them. [*The programmable memory is often called RAM, for random access memory. This is a misnomer, since read only memory is also random access memory. In onComputing we call the memory in which you can actually store programs and data by the generic terms, memory or programmable memory* . . . . ed]

Radio Shack originally planned to offer a version of the TRS-80 which had 8 K of user memory. There was a problem with quality control on the 8 K memory circuits; many of them did not work. The 4 K and 16 K memories did not have the quality problem, so the 8 K version was scrapped shortly after the TRS-80 was introduced.

Many other companies have offered kits to upgrade a 4 K machine to a 16 K machine at prices considerably below that charged by Radio Shack. For various reasons Radio Shack discourages users from installing memory devices from other sources. One caveat for the TRS-80 purchaser is that Radio Shack repair centers charge more for repairs to TRS-80s that have been modified or upgraded by someone other than technicians in Radio Shack repair centers. In the past several months, Radio Shack has been installing a numeric keypad along with the 16 K memory as a bonus, which makes authorized memory expansion more attractive. This numeric keypad is available on new 16 K units as standard equipment.

If you decide to have a memory expansion procedure performed at

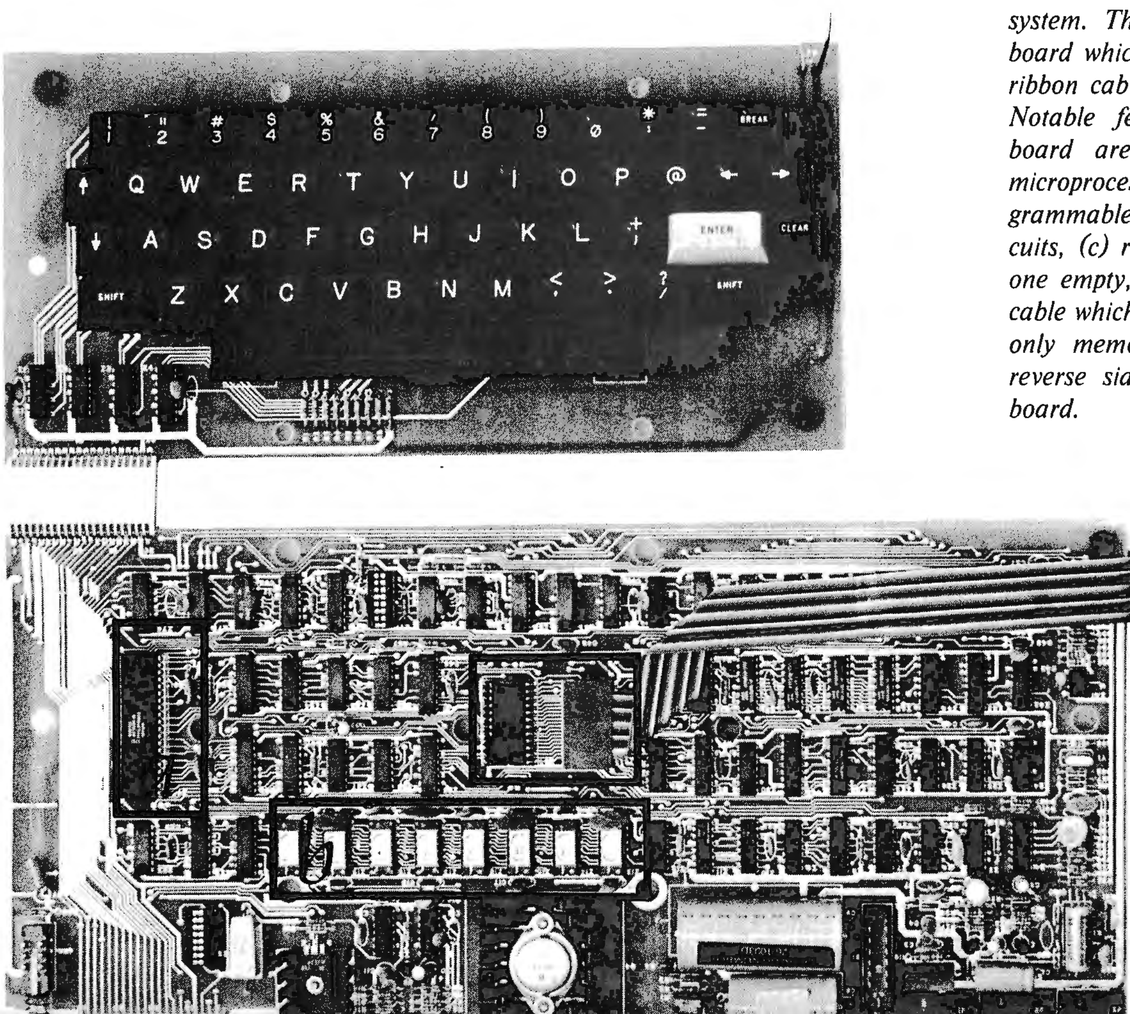

Photo 2: The component side of the two printed circuit boards that form the central part of the TRS-80 system. The keyboard occupies one board which is connected by a short ribbon cable to the processor board. Notable features of the processor board are as follows: (a) Z-80 microprocessor, (b) the eight programmable memory integrated circuits, (c) read only memory sockets, one empty, one connected to ribbon cable which leads to the Level II read only memory circuit board on the reverse side of the main processor board.

the Radio Shack repair center, you might want to ask to have the old 4 K memory circuits returned to you. There should be no extra charge, and in most cases you can get the old memories back.

Expanding the System

The design of the TRS-80 system is modular. The key module for adding capability is the TRS-80 expansion interface. This is a long box which fits under the video monitor and acts as a base for it. It contains its own power supply, and can house the power supply for the keyboard and processor unit.

The expansion interface module allows you to expand the memory beyond the 16 K capacity of the keyboard unit. Applications requiring large programs can benefit from the expansion box's capacity of 32 K bytes of programmable memory. With the keyboard and processor unit housing 16 K, this makes almost 48 K available for program and data storage. Note that the large memory is optional.

The expansion box contains the electronic circuits needed to hook up floppy disk drives, printers, and dual cassette recorders. These circuits are called the device controllers.

The expansion interface may also contain an optional RS-232C serial input and output (I/O) port. This RS-232C port is a standard interface which may be used to connect a multitude of peripheral devices from various manufacturers. Note that a device may be *connected*, but it is possible that a special program must be written to *use* the device.

The expansion interface also contains a real time clock. This provides your programs with the ability to keep track of the time of day. To make the clock function, however, you must have either the disk operating system or a special subroutine written in machine language.

Printers

Radio Shack markets three printers for connection to the TRS-80 system. Two of these it calls line printers, the other is called a "quick" printer. All three are made for Radio Shack by the Centronics Data Computer Corp, a firm which has manufactured printers for many years.

Computer professionals are hesitant to agree with the appellation "line printer" as used for these products. The term is usually re-

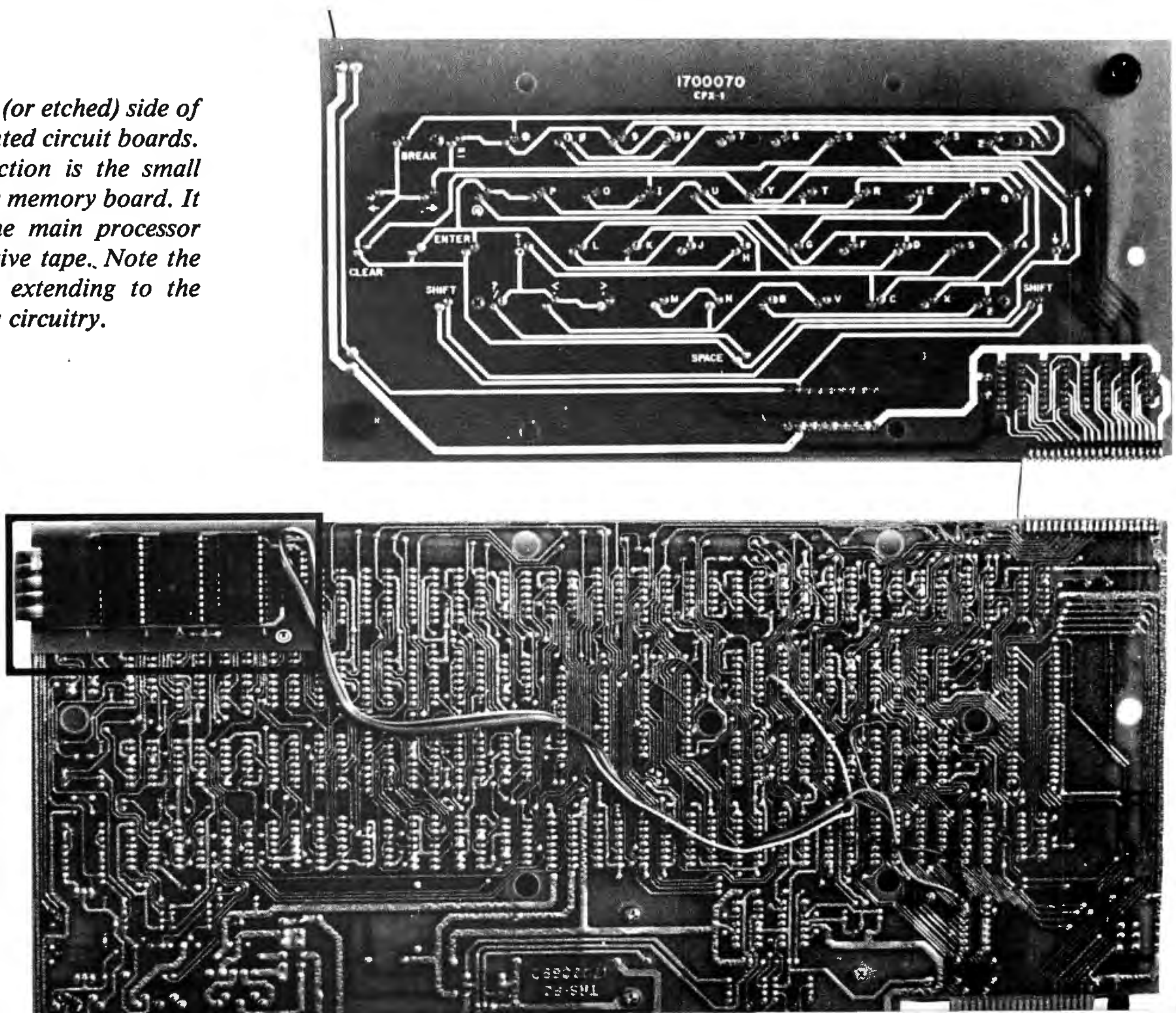

Photo 3: Reverse (or etched) side of the two main printed circuit boards. The indicated section is the small Level II read only memory board. It is attached to the main processor board with adhesive tape. Note the four small wires extending to the processor address circuitry.

Floppy disks provide relatively inexpensive, fast reliable mass storage with much greater capacity.

served for large, expensive machines which print an entire line of characters in a single operation. The proper term for these units is "high speed serial character printer," but that name is somewhat unwieldy.

The two Radio Shack line printers are essentially similar. They differ in the paper feed system. One model uses a friction feed system with a roll of paper; the other uses a tractor feed drive and folded paper. Roll paper is less expensive, but the tractor feed system gives better quality results. If you wish to print on special forms using carbon paper for multiple copies, forms registration must be precise, and the tractor feed printer is a necessity.

The quick printer prints electrostatically on special paper with an aluminum surface, whereas the line printers use impact printing. The quick printer, therefore, is useful chiefly for jobs requiring small, single-copy printout. Some people may find the metallic paper hard to read. Surprisingly, the output from the quick printer reproduces very well on office photocopiers. The quick printer has the ability to print lower case letters, but the line printers are capable only of upper case.

All three printers have the following requirements. The computer system must have Level II BASIC, the expansion interface, and a multi-pin connection cable. Some purchasers may balk at paying more money for the cable after they have already bought the printer. Unfortunately, this is one common practice in the marketing of large computers that small computer firms have copied.

Radio Shack used to sell a "screen printer" which could function with Level I BASIC and which did not require the expansion interface, but it has been discontinued. You might still find some of these units in a few scattered stores, but don't count on it.

Data Storage: Cassette Recorders

The simple TRS-80 system uses a standard audio cassette recorder for storing programs and data. This is a low cost method. It is ideal for applications where expense must be kept low and where speed of operation is not important.

The cassette recorder is automatically activated for the play and record functions by a relay inside the keyboard and processor unit. Unfortunately, this relay has proven to be a source of trouble. It sometimes sticks. Most authorities speculate that arcing at the contacts is the cause. Some users have devised circuits to reduce the current that flows through the relay, but it is annoying to have to worry about it at all. Certain specific models of cassette recorders aggravate the problem. Incidentally, the buzzing noise you hear when you turn on a Level II equipped TRS-80 is the relay going crazy during the system initialization procedure.

Level II BASIC allows you to give single letter names to programs stored on a cassette tape. The computer can then search for a specific program along the tape. The search time, however, can be tediously long. I prefer to make voice announcements on the tape at the point just before the recording of the program starts. You may search for a program by ear using the high speed cue and review function of the recorder, if you have the Radio Shack Model CTR-41 (which is standard with the TRS-80). It is also possible to give more information about the program in a vocal announcement. The search procedure may be aided by constructing an external switch and speaker circuit. I have found that it is not difficult to tell the difference between a human voice and computer data on the tape, even at high tape speed.

With the expansion interface, you can use two cassette recorders. This makes it possible to update files stored on cassette. There is a bug in the dual cassette arrangement, however. An error in the Level II read only memory prevents the cassette verification procedure from working with the second cassette recorder. This is the procedure invoked by the CLOAD? command.

The speed of cassette storage is slow. Level I uses a data rate of about 250 bps (bits per second). Level II improves this by a factor of two with its data rate of 500 bps. The amount of data (when I say "data" I am including programs, too) which may be stored on a single cassette varies according to the length of the cassette. You should use only high quality tape. Cheap tape has dropouts, which are areas where oxide has departed from the plastic base. Dropouts cause loss of data, and loss of data causes loss of time and frustration.

Data Storage: Floppy Disks

Floppy disks provide relatively inexpensive, fast, reliable mass storage with much greater capacity. Floppy disk storage is recommended over cassette storage for most serious applications of the TRS-80 (or any computer, for that matter).

The TRS-80 Mini-Disk system uses 5 inch diameter diskettes. One to four disk drives may be attached to the TRS-80 through the expansion interface. It is also necessary to have Level II BASIC. Each floppy disk can hold 85,760 bytes of information.

It is necessary to have a set of programs telling the computer how to use the disk. This set of programs is called the disk operating system (commonly abbreviated as DOS in computer literature). With

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the purchase of the first disk drive, you receive a system disk containing TRSDOS, the disk operating system for the TRS-80. This and the new version of the BASIC interpreter, Disk BASIC, occupy some 30,000 bytes of storage on the system disk. It therefore has about 55,000 bytes remaining for user storage. The second, third, and fourth disk drives need not contain the system software, and thus have their entire capacity available for program and data storage.

One key to the speed of the floppy disk (and other types of disks, as well) is the method of searching for data. When we use a cassette and want the computer to find a particular program, the computer must start the cassette and read every program that comes before the one we want. This type of behavior is called *serial access*. The floppy disk, on the other hand, is a *random access* device. It can skip over tracks to place the read head directly onto the track we are interested in — the track which contains the desired program. It then need wait only a small fraction of a second while the disk rotates around to the beginning of the program, and can proceed to transfer the program into the computer's programmable memory.

It is useful, if not virtually necessary, to have at least two drives on a given system. This makes it easy to copy disks and to update data files. It is possible to get along with only a single drive, however. The TRSDOS disk operating system includes a program which can be used to copy disks on a single drive system, albeit with a lot of manual changing of disks.

There are independent firms marketing compatible disk drives for the TRS-80. You have to buy the first one from Radio Shack to get TRSDOS, but the other drives may be used for the second through fourth units. Other firms are marketing disk drives with different characteristics, such as higher speed or larger capacity. However, it is not the purpose of this article to discuss them.

Other Peripheral Approaches

A few firms sell devices that allow the connection of S-100 circuit boards to the TRS-80. This is desirable because of the large number of products on the market built to work with the S-100 bus system.

The S-100 bus is a format for connecting computer circuits together. It was originally called the Altair bus, since it was first used in the MITS Altair 8800 computer.

Some S-100 peripherals, however, won't work with the TRS-80, even using one of the adapting devices. S-100 circuits utilizing direct memory access would raise havoc with the TRS-80's dynamic memory, and therefore cannot be used. This excludes from use some of

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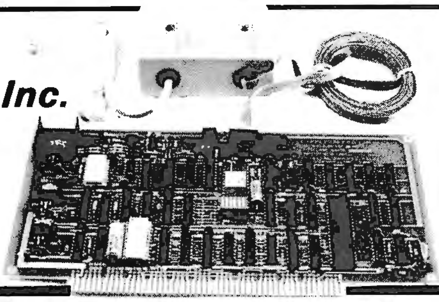

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the more interesting S-100 peripherals.

System Documentation

Documentation can make a system useful or useless. The instructions and other material furnished with the TRS-80 are, if not perfect, at least satisfactory explanations of how to get the computer to do what you want.

The *Users Manual for Level I TRS-80* is a good introduction to programming in the BASIC language for those who are new to computers. It contains step-by-step lessons to help the user sort out the secrets of programming. Its humorous style makes it enjoyable to read. It has even been recommended by some as a text on BASIC for all computers, although there are certain sections which only apply to the TRS-80.

The *Level II BASIC Reference Manual* is written on a somewhat more advanced plane. It assumes that you have learned everything in the Level I manual, or are an experienced computer user. Unfortunately, it contains a few slight errors, and some omissions, one of which caused me some trouble. (It doesn't tell you that the CLEAR statement disables a preceding DIM statement.) The reference manual for Disk BASIC details the intricacies of working with the floppy disk using the extensions to BASIC provided in TRSDOS.

A book not included in the purchase price of the system, but one in which many people will be interested, is the *TRS-80 Microcomputer Technical Reference Handbook*. It is written "for the technical person, by a technical person." It contains a thorough explanation of how the circuitry of the computer functions. Intrepid TRS-80 owners who wish to modify their machines or connect them to myriad unusual peripheral devices will find this volume invaluable.

Software: Programs and Such

Radio Shack has, at this writing, some dozens of programs and packages of programs available off-the-shelf. These include simple game programs, statistical procedures, business application software, and some supplementary system software (such as the editor/assembler).

The most interesting software, though, is usually available from outside software distributors. There are hundreds, if not thousands, of busy programmers across the world writing programs for the TRS-80. Many small consulting firms are springing up to meet the demand for programmers in applications work for the TRS-80 and other microcomputers.

Microsoft has announced the availability of a FORTRAN system for the TRS-80. (That should be popular among scientists and engineers.) By the time you read this, Radio Shack may have announced the availability of the popular CP/M operating system by Digital Research for the TRS-80.

System Capability

The TRS-80 system uses the Zilog Z-80 microprocessor circuit. The programmable memory is of the dynamic, rather than of the static type. The keyboard and the video display are implemented as memory-mapped I/O (input and output) devices. These characteristics were designed to take advantage of the power of the Z-80 processor. This particular processor was designed to be an enhanced version of the 8080 processor, and, with one minor exception, it executes all 8080 programs the same way that the 8080 executes them.

The video display shows 16 lines of 64 characters each. Under program control the format may be changed to lines of 32 characters. Graphics and text may be mixed on the screen. The graphic resolution is somewhat coarse, with a 48 by 128 cell matrix. Color graphics are not available.

The system recognizes and can produce only upper case letters. The explanation for this is that a choice had to be made between having lower case letters or graphics, and graphics was chosen. Several experimenters have discovered ways to add lower case capability to the TRS-80, and some firms are offering conversion kits for sale for as low as $20. Surely it would not have been that much trouble to build it in at the factory. Of course, lower case is essential to anyone wishing to do word processing. As it stands, however, it is necessary to break the seals and void the warranty to have lower case installed.

The bandwidth required by the 64 character line display is rather large, at about 5 MHz. Therefore, it is preferable to use a good quality video monitor, such as the Radio Shack unit, with the computer, rather than to try saving money by using a radio frequency (RF) converter and connecting it to your television set.

You, the Computer User

The decision to purchase a computer is not to be taken lightly. A well-equipped system can cost as much as an automobile. And, like the automobile purchaser, you must examine your needs carefully.

The TRS-80 holds a strong position in the microcomputer market. Much software has been and is being developed for it. It has drawbacks, but it is still an amazing product of technology, capable of applications that no one has yet thought of.■

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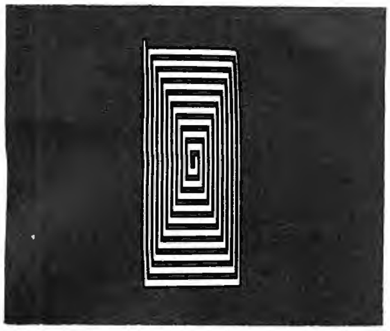
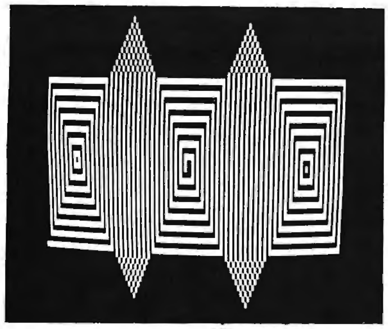
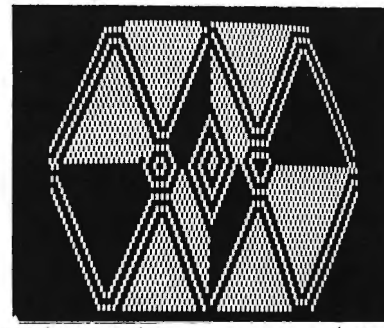
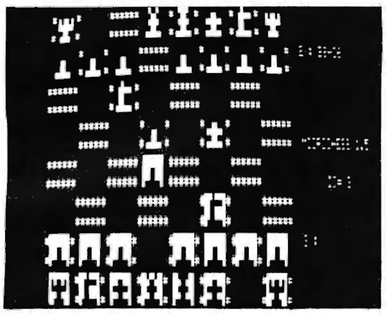
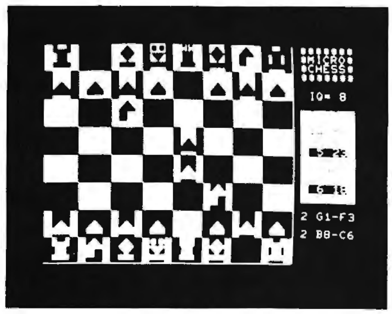
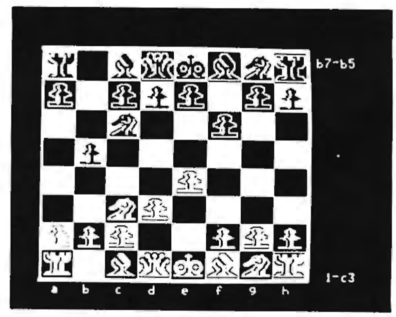




***NEW!* THE ELECTRIC PAINTBRUSH** by **Ken Anderson** for 4K Level I and II TRS-80s: Create the most dazzling graphics displays you have ever seen with a minimum of effort. *The Electric Paintbrush* is actually a simple 'language' in which you can write 'programs' directing your paintbrush around the screen—drawing lines, turning corners, changing white to black, etc. Once defined, these programs may be called by other programs or repetitively executed, each time varying the parameters of brush movement. The machine language interpreter executes your programs almost instantaneously, allowing you to create real-time, animated graphics displays. The screen photos above are actually 'snapshots' of the action of a single one-line program over about thirty seconds. Mesmerize your friends with visual effects they've never seen on a TV screen! There's no limit to the variety of exciting and artistic graphics displays you can create with *The Electric Paintbrush*. And it's available now for only **$14.95**



MICROCHESS is the culmination of two years of chessplaying program development by **Peter Jennings**, author of the famous 1K byte chess program for the KIM-1. MICROCHESS 2.0 for 8K PETs and 16K APPLEs, in 6502 machine language, offers 8 levels of play to suit everyone from the beginner learning chess to the serious player. It examines positions as many as 6 moves ahead, and includes a chess clock for tournament play. MICROCHESS 1.5 for 4K TRS-80s, in Z-80 machine language, offers 3 levels of play (both Level I and Level II versions are included and can be loaded on any TRS-80 without TBUG). MICROCHESS checks every move for legality and displays the current position on a graphic chessboard. You can play White or Black, set up and play from special board positions, or even watch the computer play against itself! Available now at a special introductory price of only.............. **$19.95**

BRIDGE CHALLENGER by **George Duisman** for 8K PETs, Level II 16K TRS-80s, and 16K APPLEs: You and the dummy play 4 person Contract Bridge against the computer. The program will deal hands at random or according to your criterion for high card points. You can review tricks, swap sides or replay hands when the cards are known. No longer do you need 4 people to play! **$14.95**

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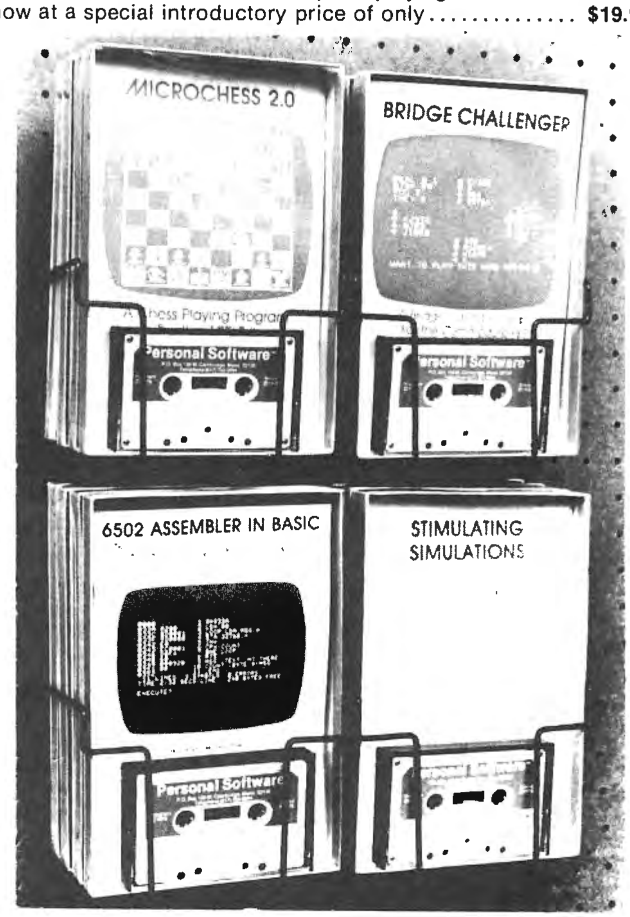

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BOOK REVIEW

BASIC and the Personal Computer
by Thomas A Dwyer and Margot Critchfield
Addison-Wesley Publishing Co, Reading MA, 1978
438 pages, paperback
$12.95

Reviewed by
Raymond GA Cote

If you own or use a personal computer, chances are you will be using the BASIC language. Thomas Dwyer and Margot Critchfield have written a book to show personal computer users how to make BASIC work for them.

BASIC and the Personal Computer starts with an overview of personal computers that were available in 1978, when the book was printed, along with a quick look at what a computer consists of, and how keyboards, terminals, televisions, and memory are added to the basic processor. Packaged computer systems, which can be purchased complete, and ready for use, are also described.

After explaining what a computer is and what it does, the authors perform what they call the "8 Hour Wonder." Chapter 2 explains everything you need to know about BASIC in eight sections, each section arranged as a 1 hour lesson. The text is accompanied by many examples and program listings. This is one of the strong points of the book. With it you can perform all the exercises on a computer as you come to them in text. This is definitely the easiest way to learn a language: working with it immediately and seeing what the new commands you are learning actually do.

Both direct and indirect mode operation are covered. In direct mode, the computer can be used like a calculator, performing functions as you give them to the computer. Indirect mode is also known as program mode. This mode allows you to have a set of instructions which will be executed at a later time as a program.

Other sections cover graphics applications. Most of the graphics described in this book can be performed on any alphanumeric terminal. Graphic exercises range from simple sine function plotting to simulating a pin ball machine. A very interesting function is the one that generates continued fractions.

BASIC and the Personal Computer also covers topics such as word processing, computer games, computer art, working with data bases, and performing simulations of physical systems.

The final chapter deals with extensions to computers: light pens, color graphics, and music and speech synthesis.

BASIC and the Personal Computer is well annotated with descriptive figures and listings. Each chapter ends with a series of exercises that cover the topics discussed. The reader who performs these exercises will have little difficulty in learning BASIC. *BASIC and the Personal Computer* will take you on a step by step journey through the world of BASIC and leave you at the doorstep of imagination.■

Ray Cote is editor-in-chief of BYTE *magazine.*

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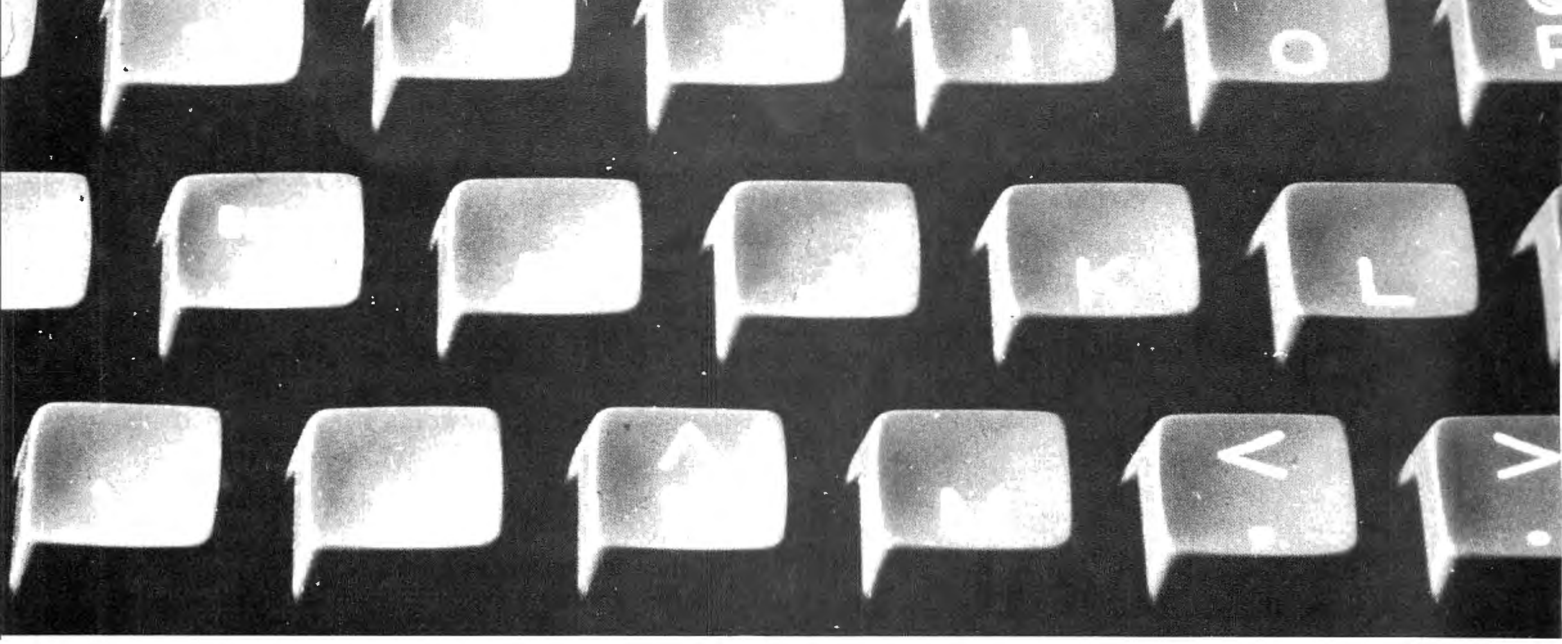

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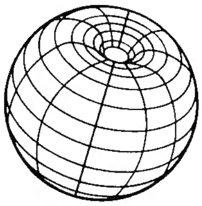
A  Personal Computer Directory

by Fred Ruckdeschel

Fred Ruckdeschel is principal scientist at Xerox Corp in Webster NY, dealing with scientific instrumentation, experimental physics and simulation.

Picking the right personal computer can be a challenging task, especially when you consider the bewildering array of single board computers, appliance style all-in-one computers, floppy disk systems, and other devices on the market today. The following chart is designed to help you sort out the clutter of components, and pick a better computer.

Getting the Most Out of the Table

The table contains a considerable amount of information. The abbreviations used are explained in the accompanying key. To allow a better measure for comparison in each category, I have made an attempt to equalize the products. This was done by adding options in some cases to get a particular system into the same range of features as the general computer "population." For example, programmable memory options may have been added, or a video output, or a terminal (video plus keyboard). The effect of these additions on the cost of the system is indicated by the price in parentheses which follows the base price. I have also included a note in the comments column, explaining what has been added. The rules I followed for these additions are:

Video terminal (includes keyboard)	+$750
Color video monitor	+$300
Black and white video monitor	+$150
Keyboard	+$100

Prices range from roughly $150 for the most basic single board computer kit to $15,000 for an elaborate dual floppy disk computer with a printer, video terminal, and other amenities. The designation (k) following the price stands for kit.

In many cases there is no entry in a particular position. This is often the case in the "read only memory" column, which indicates the amount of read only memory supplied. In most cases such memory exists, since the literature indicated a read only memory monitor, but the size was not given. Thus a blank does not necessarily stand for a missing feature, but rather a lack of information.

The "software" column indicates the software supplied *or available.* A word of caution is in order. Some effort has been made to be specific, but there is quite a variety of software. For example, the term BASIC does not stand for a unique language, but rather a type; the same applies to the term monitor. In the past year CP/M (a floppy disk operating system) has become available for many computer systems. Although not indicated on the tables, the availability of CP/M opens the door to other software, such as BASIC, FORTRAN

and COBOL (if the system uses the right microprocessor).

The column entitled "terminal I/O" (meaning terminal input/output) indicates the terminal capability supplied with the system. In some cases a complete video terminal is provided; in others only a serial I/O port. An I/O (input/output) port is a physical location on a computer where information can be entered in or transmitted out. A parallel I/O port can transmit large amounts of data simultaneously, compared to a serial I/O port.

Designations such as "80 by 24 characters" indicate the number of columns and rows, respectively, of characters that can be displayed on the video display.

Since the option for high speed printing or data transmission is often of interest, the availability of a parallel I/O port is indicated. However, it should be noted that the existence of the port is not sufficient in itself for a printer output; software driver programs are also required.

Types of Computers

Which personal computer is right for you? This question is discussed in "Getting Started in Computing," by Elizabeth Hughes, elsewhere in this issue, but a few words may be in order here.

Buying a single board computer is the least expensive way to get started, but some may require that you perform some soldering to attach power supplies, etc. Some may be lacking a case. Another consideration is that most single board computers are sold with limited amounts of memory (at the low end of the price range).

There are two general types of single board computers; those with onboard keypads (or keyboards) and LED displays, and those without. As with any attempt at classification, there are products falling between the two types and outside them. For example, the Model One Home Computer by Interact Electronics contains a keyboard, but requires a video monitor for display. As an example of a single board computer which is outside the two general groups, consider the AIM 65 by Rockwell. It not only contains a keyboard and 20 digit display, but also sports a printer. In fact, if it were not for its unencased single board configuration, it might better be classified as a cassette based microcomputer.

If you have no other computer equipment, a single board microcomputer containing a keypad and LED display can be purchased for under $200 (add perhaps $25 for a power supply). Given this background, the Digi-Key Nibbler (for instance) would not be a good choice, since it requires a complete terminal for operation. However, if a keyboard terminal is available (such as a Teletype), the Nibbler can be an excellent choice because of its low price and BASIC in programmable memory. Thus the variety in the market offers the opportunity to obtain a single board microcomputer to fit almost any need and situation.

Although most entries in the table contain provisions for mass storage in the form of a tape recorder interface or disk drive, some do not. The absence of such a capability severely limits the use of the device — this should be carefully considered.

Going beyond the single board units we find a broad set of categories including the "mainframe" system, the "appliance" style all-in-one computer, large (and expensive) business and technically-oriented systems, and numerous "in between" systems equipped with one or more floppy disk drives or cassette units for mass storage. The mainframe systems usually have "mother boards" which are large printed circuit boards into which other boards can be plugged to expand the capabilities of the system. Such expansion can take the form of additional memory, cassette and floppy disk interfaces, printer interfaces, voice synthesizers and recognizers, and so on.

The appliance (or all-in-one) computers, represented by the PET, Radio Shack, Apple II, and Atari units (among others), are sold as integrated packages that can be plugged in and run as ready-to-go "appliances."

Some very large sophisticated systems have been included mainly for comparison purposes. These units offer capabilities approaching, and sometimes surpassing, those of the larger minicomputers.

Many of the computers come with one or more floppy disk drives. The latter are available in two sizes: 5 inch and 8 inch. You can add floppy disks to your system initially or later on; the added capability is well worth it if you plan to do a significant amount of work with your system.

Caveats and Conclusions

Every attempt has been made to make the table as accurate and complete as possible, although there are few constants in this quickly changing field. Prices were accurate at the time of writing, but may have changed since then. Some of the computers listed may no longer be available, or may be available in a different form; and of course new models come out every month. The best way to be sure is to visit your local computer store. If this is impractical, write to the manufacturers for the latest catalogs and price sheets.

Knowing what is available in the market will put you in a much better position to pick the right personal computer. Happy hunting!

Manufacturer and Model	Programmable Memory	Read Only Memory	Software	Terminal I/O	Mass Storage	Other I/O	Price	Comments
ACFA-8	16 K		Monitor, 8 K BASIC	Color RF video signal, keyboard	Cassette, Kansas City standard	RS-232C, TTY	$695 $595 (k) ($895)	Uses Motorola 6808 processor. (Price) includes color video display.
Allied Computers MCT-1				Keypad, LED display			$720	System design from India.
Altos Computer Systems ACS 8000	32 K	1 K			8 inch IBM compatible floppies, single sided, single density	RS-232C, PIO	$3840	CP/M disk operating system and DMA (direct memory access) available. (Price) includes video terminal (with keyboard).
Andromeda Systems	20 K		Monitor, BASIC, FORTRAN, FOCAL, all available	ADM-3a terminal (video and keyboard)	Dual 8 inch floppies	SIO	$8317	16 bit LSI-11 system. Uses DEC LSI-11 bus. Parallel I/O available.
APF Electronics Pecos 1	16 K	24 K	PeCos (modified BASIC)	9 inch video, 16 by 40 characters, 60 keys	Dual cassette decks, 800 bits per second		$1695	Uses Radio Shack interface.
Apple Computer Co Apple II	4 K	8 K	Monitor, 6 K BASIC in read only memory	Color RF video signal, 40 by 24 characters, keyboard	Cassette, 1500 bits per second	Speaker, paddles	$970 ($1270)	Has case and integer BASIC. Uses Apple bus. (Price) includes color television. Parallel I/O available. High resolution graphics capability. Wide variety of software available.
Apple II (upgraded)	16 K	8 K	Monitor, 6 K BASIC in read only memory	Color RF video signal, 40 by 24 characters, keyboard	5 inch floppy, cassette 1500 bits per second	Speaker, paddles	$1690 ($1990)	Same as above. Floating point BASIC available.
Apple II with options	48 K	8 K plus FWC (see comments)	Monitor, Extended BASIC	Same as above	Dual 5 inch floppies, cassette, 1500 bits per second	SIO, PIO, speaker, paddles	$3070 ($3370)	Same as above. FWC (firmware card) has floating point BASIC. UCSD Pascal available.

Notations Used in the Directory

Bi-phase: a cassette tape recording mode.

Bus: a set of parallel wires used to transmit data and information between parts of the computer.

Cassette: unit includes a cassette tape recording interface (does *not* include cassette deck).

CUTS: Processor Technology tape recording mode.

Erasable read only memory: a read only memory that can be programmed by the user, and can also be erased by means of concentrated ultraviolet light. Erasable read only memory size is expressed in bytes. Often abbreviated EROM.

I/O: single bit of bidirectional data input and output.

(k): indicates kit price (unassembled).

K: short for 1024 (or 2^{10}). For example, 3 K bytes of memory is the same as 3072 bytes of memory.

Keyboard: full function keyboard (uses ASCII standard character code).

Keypad: limited function keypad on printed circuit board or on front panel.

LED display: light emitting diode display.

Monitor: program or collection of programs interpreting the basic set of commands required to use a system.

PIO: 8 bit wide parallel input/output.

(Price): refers to altered price in parentheses. Reflects the addition of some needed hardware or software to "normalize" the system so it can be realistically compared with other systems.

Programmable memory: memory with changeable content, as opposed to read only memory (the content of which is fixed during manufacture). Programmable memory is where most programs and data are stored. Programmable memory size is expressed in bytes.

Read only memory: computer memory which is permanently programmed with one group of frequently used instructions. Read only memory does not lose its program when the power is turned off, and the program cannot be changed by the user. In many personal computers, the BASIC language interpreter and operating system are contained in read only memory. The term is sometimes abbreviated as ROM. Read only memory is expressed in bytes.

RF: high frequency video display signal provided with the unit, but not the video display itself.

RS-232C: a popular standard serial interface which may be used to connect peripheral devices, such as video displays, modems, printers, etc.

SIO: serial input/output.

Tarbell: a tape recording mode.

TTY: 20 mA current loop serial interface for connection to a Teletype.

Video output: used in the comments column to indicate the addition of a video monitor to the system. A video monitor is a television set modified for use with a computer.

Manufacturer and Model	Programmable Memory	Read Only Memory	Software	Terminal I/O	Mass Storage	Other I/O	Price	Comments
Atari								
Model 400	8 K	8 K	BASIC	Color RF video signal, graphics, 320 by 192 lines of resolution, keyboard, 57 keys	Cassette, 300 and 600 bits per second	SIO game paddles	$500 ($800)	Flat touch-sensitive keyboard. Color graphics has eight levels of brightness. Atari BASIC is mostly compatible with Microsoft BASIC. Slot for read only memory program cartridge. Memory is not expandable. (Price) includes color television. Available late 1979.
Model 800	8 K	8 K	BASIC	Color RF video signal, keyboard, 57 keys	Cassette deck	SIO, game paddles	$1000 ($1300)	Same as above, with two cartridge slots; memory is expandable. Conventional keyboard. Available late 1979. (Price) includes color television.
Bytemaster								
Master-1	19 K		Monitor	9 inch video display, 64 by 16 characters, keyboard	Cassette 1100 bits per second		$2495	Four parallel I/O ports available.
Master-4	34 K		Monitor	Same as above	5 inch floppy		$3245	Same as above.
Central Data								
Computer System Board	768	1 K	Monitor, including assembler, BASIC available	RF video signal, 80 by 16 characters	Cassette, Kansas City standard, 300 bits per second		$275 $225 (k) ($375)	Single board computer. (Price) includes power supply (required) and video output. Expansion to S-100 bus available for $110. BASIC requires more memory.
CGRS Microtech								
System 6000 Level I: Tutorial	256			Switches, LED display		Front panel	$240 $200 (k)	Single board computer. Uses 6502 processor. Parallel I/O available.
System 6000 Level XI Portable	1 K		Monitor	RF video signal	Cassette	SIO	$895 $745 (k) ($1495)	Uses S-100 bus. Comes in metal suitcase. (Price) includes video terminal (keyboard and screen). Parallel I/O available.
CMC Marketing								
PT 212/80	32 K	2 K	CP/M disk operating system, assembler, editor, FORTRAN, Super BASIC	Video, 80 by 24 characters	Dual 8 inch floppies, IBM compatible	3 PIO, 3 SIO	$5995	Several versions available.
Commodore								
KIM-1	1 K	2 K	Monitor	Keypad, LED display	Cassette 135 bits per second	PIO, TTY	$180	Single board computer. Uses 6502 processor. Requires power supply (not included).
PET 2001	8 K	14 K	Monitor, BASIC on read only memory	9 inch video display, 40 by 25 characters, 73 keys	Cassette deck, 700 bits per second	PIO	$795	Self-contained "all-in-one" computer. Nonstandard size keyboard. Uses IEEE 488 bus. Software available from a variety of sources.
Comptronics								
1080 F-8 Microcomputer	2 K	1 K	Monitor			4 PIO, SIO	$275 $239 (k) ($989)	(Price) includes power supply and terminal (video plus keyboard). Uses S-100 bus.
Compucolor								
Compucolor II Model 4	16 K	16 K	Monitor, Disk BASIC	13 inch color video monitor, 64 by 32 characters, keyboard	5 inch floppy	RS-232C, 25 I/O lines	$1795	Complete terminal system; uses Compucolor bus.

Manufacturer and Model	Programmable Memory	Read Only Memory	Software	Terminal I/O	Mass Storage	Other I/O	Price	Comments
Computer Data Systems								
Accountant			Business software packages	Video terminal (includes keyboard)	Dual 5 inch floppies	Dot matrix printer	$5995	Turnkey business system.
Computer Power and Light								
Compal 80	16 K		Monitor, BASIC	9 inch video display, 64 by 16 characters, keyboard	Cassette 300 and 2400 bits per second	RS-232C, TTY	$2300	32 K of memory available for $575.
Computer Products of America			BASIC, business software packages	12 inch video display, DECwriter II printer.	Dual 5 inch floppies (North Star)		$5995	Business-oriented system.
Cromemco								
Single Card Computer	1 K	8 K	Monitor, 3 K BASIC available on programmable read only memory	RS-232C, TTY		PIO	$495 $395 (k) ($1145)	(Price) includes power supply and programmable read only memory software (both required). Uses Z-80 processor, S-100 bus.
Z-2D	8 K	1 K	Monitor, BASIC available	RS-232C	5 inch floppy		$2095 $1495 (k)	Turnkey mainframe. Parallel I/O available. System has programmable read only memory programmer. Uses S-100 bus.
System Two Disk Computer	32 K		Monitor, also available: assembler, BASIC, FORTRAN		Dual 5 inch floppies, IBM compatible	PIO, SIO	$3990 ($4740)	Turnkey mainframe. (Price) includes terminal (video plus keyboard). Uses S-100 bus.
System Two with options 003, Z3	48 K	1 K	Monitor, 16 K BASIC, assembler, FORTRAN		Dual 8 inch floppies, IBM compatible	PIO, SIO	$6980 ($7730)	Same as above.
Digi-Key								
Nibbler	2 K	4 K	NIBL 4 K BASIC on read only memory			SIO	$150 ($900)	(Price) includes terminal (video plus keyboard), power supply. Uses National SC/MP processor.
Digital Microsystems								
DSC-2	32 K			Video terminal (includes keyboard)	Dual 8 inch floppies	4 RS-232C	$4995	CP/M disk operating system software available. Uses Digital Microsystems bus.
DSC-80	64 K			Video terminal (includes keyboard)	Dual 8 inch floppies, double density		$6185	Same as above.
Digital Sport Systems								
Sirius II	32 K	8 K	Monitor, Disk BASIC	RF video signal, keyboard, 64 keys	5 inch floppy	RS-232C	$1850 ($2000)	(Price) includes video output.
Sirius II (expanded)	48 K	2 K	Disk BASIC	RF video signal	Dual 5 inch floppies	2 RS-232C PIO	$2950	Turnkey mainframe system.
UC 2000 System D	16 K	1 K	Monitor, BASIC	12 inch video display, 64 by 16 characters, keyboard	5 inch floppies, cassette, bi-phase, Kansas City standard		$3649	Uses S-100 bus. Parallel I/O available.
E&L Instruments								
MMD + M1 option	1 K	256	Monitor	Keypad, binary display	Cassette 300 bits per second	TTY	$775 $570 (k)	Breadboard training system; single board. Uses 8080A processor.

Manufacturer and Model	Programmable Memory	Read Only Memory	Software	Terminal I/O	Mass Storage	Other I/O	Price	Comments
Electro-Atomic Products								
UHC-68	4 K		Monitor, assembler, BASIC on read only memory	Color RF video signal, keyboard	Cassette		$749 ($1049)	Color graphics. (Price) includes color video output.
Electronic Control Technology								
TT-8080-S	18 K	2 K	Monitor			SIO	$1375 $1125 (k) ($2125)	(Price) includes terminal (video output plus keyboard). Uses S-100 bus.
Electronic Product Associates								
Micro 68	128	512	MON-1 monitor	Keypad, LED display		SIO	$495	Comes with power supply and case. Uses 6800 processor.
Micro 68b	8 K		Monitor	Keypad, LED display	Cassette	RS-232C, TTY	$1878	Uses 6800 processor. Parallel I/O available.
Electronic Tool								
ETC-1000	1 K	256	Monitor	Keypad, LED display		PIO, 2 SIO	$775	Comes with cabinet. Uses Z-80 processor.
ETC-1000/D 48 K Disk System	48 K	256	Disk operating system	Keypad, LED display	Dual 8 inch floppies, IBM compatible, cassette	2 RS-232C, 8 I/O lines	$6450 ($7200)	Parallel I/O included. (Price) includes terminal (video plus keyboard).
Environmental Technology								
Mighty Byte + options 10688, 10692	1 K	8 K	Keypad, LED display			PIO	$358	Single board computer. Power supply required (not included).
Exidy								
Sorcerer (also PS-80 from Personal System Consultants)	8 K	4 K	Monitor, BASIC available	RF video signal, 512 by 240 lines of resolution, 64 by 30 characters, keyboard	Dual cassette decks	RS-232C, 300 and 1200 bits per second, PIO	$895 ($1045)	All-in-one, "appliance" type computer. High resolution graphics. BASIC "ROM Pac" available for $99. S-100 expansion, $150. (Price) includes video output.
Findex								
Model 180	49 K	8 K	BASIC	Plasma display, 40 by 6 characters, keyboard	5 inch floppy	SIO	$4900	Parallel I/O available. Bubble memory version available.
Firebird								
Smarts II	32 K	2 K	Monitor	Color RF video signal, 64 by 16 characters, keyboard, 63 keys	5 inch floppy	RS-232C, game I/O	$1595 ($1895)	Sound effects. (Price) includes video output. Parallel I/O available. Uses S-100 bus.
Gimix								
Ghost 6800	8 K	2 K	Monitor	RF video signal		PIO	$1195 ($1445)	Uses SS-50 bus, 6800 processor. (Price) includes video output. SwTPC/MSI software compatible.
Harris	256		Monitor	Keypad, LED display, RF video signal	Cassette	RS-232C, TTY, PIO	$550 ($700)	Uses 12 bit AM-6100 processor; PDP-8e software compatible. Parallel I/O available. (Price) includes video output.
Heath								
Microprocessor Trainer ET-3400	256	1 K	Monitor	Keypad, LED display			$190 (k)	Breadboard system, used as part of Heath microcomputer course. Uses 6800 processor.
ETS-3400	512	1 K	Monitor	Same as above		Digital to analog converter	$270 (k)	Upgraded version of above.
H8 plus H9 terminal	8 K	1 K	Monitor, BASIC available	Keypad, LED display, H9 video terminal, 12 by 80 characters, keyboard	Cassette, 1200 bits per second	SIO	$1221 (k)	For an additional $218: 16 K, plus assembler, text editor, BASIC on cassette. Uses Benton Harbor bus. Parallel I/O available.

Manufacturer and Model	Programmable Memory	Read Only Memory	Software	Terminal I/O	Mass Storage	Other I/O	Price	Comments
H11 plus H9 video terminal and H10 paper tape reader	16 K (8 K words)		Assembler, BASIC, FOCAL	H9 video terminal, 12 by 80 characters, keyboard	H10 paper tape unit	SIO, PIO	$2328 (k)	Uses 16 bit LSI-11 processor. Compatible with Digital Equipment Corp (DEC) software. Floppy disk subsystem available.
Iasis								
ia7301	1 K	1 K	Monitor	Keypad, LED display	Cassette	2 I/O lines	$525	Requires power supply (not included). Uses 8080 processor. Unit is part of a training course (on six cassettes).
IMSAI								
8048CC-ROM Single board computer				Keypad, 24 keys, LED display	Cassette	5 relays, 22 I/O lines, TTY	$349 $299 (k)	Requires power supply (not included). Erasable read only memory version costs $200 more. Has parallel I/O.
I-8080 with 8 K, programmable read only memory (PROM)	8 K	512	Assembler, editor, BASIC		Cassette	2 PIO SIO	$1670 ($2420)	BASIC expansion mainframe with front panel slots, etc. (Price) includes terminal (video plus keyboard).
PCS 80/100	16 K		Monitor, 8 K BASIC	5 inch video display, keyboard	Cassette (Tarbell)	SIO, 2 PIO	$2670 $1886 (k)	Integrated system; has cassette software. Uses S-100 bus.
PCS 80/200	16 K	1 K	Monitor, assembler and BASIC available	12 inch video display, keyboard	5 inch floppy	RS-232C	$3357 $2610 (k)	Uses S-100 bus. Parallel I/O available.
VDP-40	64 K	2 K	CP/M+ disk operating system available	9 inch video display, 80 by 24 characters, keyboard, 62 keys	Dual 5 inch floppies	RS-232C, PIO	$5295	Terminal-like system. Uses S-100 bus.
VDP 80/1050	64 K	2 K	Monitor, BASIC, FORTRAN, assembler, editor	12 inch video display, 80 by 24 characters, keyboard, 86 keys	Dual 8 inch floppies, double-sided, IBM compatible	RS-232C, PIO	$7745	Similar to above. Several BASICs available.
Industrial Micro Systems	48 K	1 K			Dual 8 inch floppies	SIO	$3736 ($4486)	8080A processor, S-100 bus, parallel I/O available.
Infinite Inc								
UC 2000-A	8 K	1 K	Monitor, BASIC	12 inch video display, 64 by 16 characters, keyboard, 56 keys	Cassette, Kansas City bi-phase standard		$2266	S-100 bus. Parallel I/O available.
UC 2000-E	48 K	1 K	BASIC	Video terminal (includes keyboard)	Dual 5 inch floppies		$5360	S-100 bus. Parallel I/O available.
Informer 2				Video signal, 64 by 16 characters, keyboard, 63 keys		4 PIO	$2350 ($2500)	(Price) includes video output.
Intel								
SDK-85, MCS-85	256	2 K	Monitor	Keypad, LED display		38 I/O lines, TTY	$350 (k)	Single board computer, design kit, has parallel I/O.
SDK-86, MCS-86	2 K	8 K	Monitor	Same as above		48 I/O lines, RS-232C, TTY	$995 (k)	Same as above, but uses 8086 processor.

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Manufacturer and Model	Programmable Memory	Read Only Memory	Software	Terminal I/O	Mass Storage	Other I/O	Price	Comments
Intelligent Systems								
Intecolor 8032	16 K	11 K	Monitor, Disk BASIC	13 inch color video, 80 by 48 characters, keyboard	5 inch floppy	RS-232C	$4495	Disk operating system in read only memory. Additional floppy disk drive for $500.
Intecolor 8090	24 K	17 K	Monitor, assembler, text editor, Disk BASIC	13 inch color video, keyboard	Dual 8 inch floppies, double sided	SIO, dot matrix printer	$12,000	Erasable read only memory programmer included.
Interact Electronics								
Model One Home Computer	8 K	2 K	Monitor, BASIC available	Color RF video signal, keyboard, 53 keys	Cassette deck	Joystick	$499 ($799)	Has television audio, uses 8080A processor. (Price) includes color video output.
Intersil								
Intercept Jr	1 K	1 K	Monitor, DECUS library software	Keypad, LED display			$326	Uses 12 bit IM6100 processor, which uses PDP-8e instruction set. Requires power supply (batteries).
Mattel Electronics								
Intellivision	16 K		Variety of cassettes and read only memory cartridges available			SIO	$500 ($800)	Price is approximate. "Hybrid" computer consisting of two modules (each about $250): a video game-like master unit and a keyboard add-on module. Available late 1979. Uses two 16 bit processors. (Price) includes color video output. Parallel I/O available.
Micral C								
Distributed Data Processing System	32 K		Monitor, assembler, editor, BASIC dialect	Video display, 80 by 24 characters, keyboard	Dual 5 inch floppies double density		$8995	All-in-one unit. FORTRAN $500 extra. Diablo printer compatible.
Micro Data Systems								
MD-690A	1 K	1 K		Keyboard, RF video signal, 64 by 16 characters	Cassette, 2400 bits per second	20 I/O lines, RS-232C	$699 $549 (k) ($900)	Uses 6502 processor. Comes in cabinet. (Price) includes video output and parallel I/O.
MDS-2	1 K	1 K	Monbug monitor	Keyboard, RF video signal	Cassette, 2400 bits per second, Manchester recording mode	PIO	$798 $579 (k) ($950)	Single board computer. Uses S-100 bus. Comes in case. MIKBUG compatible. (Price) includes video output.
System 3	32 K		Monitor, 8 K BASIC	RF video signal, 64 by 16 characters, keyboard, 64 keys	5 inch floppy		$1799 $1499 (k) ($1950)	S-100 bus. (Price) includes video output. Parallel I/O available. Pascal available.
Micro-Products								
Super KIM	1 K	2 K	Monitor	Keypad, LED display	Cassette	RS-232C	$395	Single board system. Uses 6502 processor. Parallel I/O available.
Midwest Scientific								
MSI 6800 Group 1 Package	16 K	4 K	Monitor, BASIC	RS-232C, TTY	Cassette		$1400 $960 (k) ($1710)	Has mother board. Uses SS-50 bus. (Price) includes terminal (video and keyboard). Parallel I/O available.
MSI 6800	32 K	4 K	Monitor, Extended BASIC	Video terminal (includes keyboard)	Dual 8 inch floppy	SIO	$7330 $6339 (k)	Unit comes with high speed printer. Uses SS-50 bus.
Mini Term Associates	16 K		Monitor, BASIC	Video display, keyboard	5 incn floppy		$2699	
Modern Microcomputer								
Terminal Computer	32 K		Disk Extended BASIC	Video terminal (includes keyboard), 80 by 24 characters.	Dual 8 inch floppies		$4500	Comes with business software. Parallel I/O available.

Manufacturer and Model	Programmable Memory	Read Only Memory	Software	Terminal I/O	Mass Storage	Other I/O	Price	Comments
Motorola MEK 6800 D2	256	2 K	J-Bug monitor	Keypad, LED display	Cassette, Kansas City standard	PIO	$250	Requires power supply. Uses 6800 processor.
NEC TK-80A	1 K	1 K		Keypad, LED display	Cassette, Kansas City standard 300, 1200 bits per second	3 PIO	$299	Requires power supply. Uses 8080A processor.
NESCO Able 40	32 K		Assembler, high level BASIC		Dual 5 inch floppies	RS-232C	$9160	16 bit machine.
Netronics Netronics 4 K	4 K		Monitor	Keypad	Cassette	PIO	$265	Single board computer
Cosmac Elf II			Tiny BASIC and system monitor available	RF video signal 64 by 32 characters		RS-232C TTY	$99.95 (k) ($485)	Single board computer. (Price) includes expansion power supply, cabinet, 4 K of programmable memory, keyboard, Tiny BASIC, system monitor, and video output.
North Star Horizon-I	16 K	1 K	Monitor, Disk BASIC		5 inch floppy	SIO	$1899 $1599 (k) ($2349)	Turnkey mainframe. Parallel I/O available. (Price) includes terminal (video and keyboard). Uses S-100 bus.
Horizon	48 K		Monitor, BASIC available, CP/M + standard disk operating system		Dual 5 inch floppies	PIO, SIO	$3108 $2638 (k) ($3388)	Mainframe system. (Price) includes terminal (video and keyboard), parallel I/O. Uses S-100 bus. UCSD Pascal available.
Northwest Microcomputers NMS 85/P	64 K		CP/M standard disk operating system, BASIC, FORTRAN, Pascal	12 inch video display, 80 by 24 characters, keyboard, 43 keys	Dual 8 inch floppies, IBM compatible	2 RS-232C, 2 PIO	$7495	Accounting software and UCSD Pascal available. All-in-one system.
Ohio Scientific Model 500 board	4 K	8 K	Monitor, BASIC			RS-232C, TTY	$298 ($1048)	Requires power supply. (Price) includes terminal (video and keyboard), Microsoft BASIC.
Superboard II	8 K	8 K	Monitor, BASIC	RF video signal, 64 by 32 characters, keyboard, 53 keys	Cassette	RS-232C	$598 ($748)	Keyboard in case. (Price) includes video output. Parallel I/O available.
Challenger II-P (C2-4P)	4 K	8 K	Monitor BASIC	RF video signal, 64 by 32 characters, keyboard, 53 keys	Cassette	RS-232C	$598 ($748)	Keyboard in case. (Price) includes video output. Parallel I/O available.
C3-B	48 K		CP/M + standard disk operating system	Video terminal (includes keyboard)	Dual 8 inch floppies, 74 megabyte hard disk	PIO	$13,000	Has three processors: Z-80, 6800, and 6502. Has hard disk.
Olson Electronics Olson Business Machine MD-232	32 K			9 inch video display, 80 by 24 characters, keyboard, 79 keys	Dual 5 inch floppies	Matrix printer, 60 characters per second	$5000	

Manufacturer and Model	Programmable Memory	Read Only Memory	Software	Terminal I/O	Mass Storage	Other I/O	Price	Comments
Parasitic Engineering								
Equinox 1000				Keypad, LED display			$1099 $799 (k) ($1549)	Mainframe
Pertec Computer Corp								
PCC 2000 Desk Top Computer	64 K		Disk Extended BASIC, business software	12 inch video display, 80 by 24 characters, keyboard, 90 keys	Dual 8 inch floppies, double density		$15,000	All-in-one case.
MITS Attache	17 K	1 K	Monitor, BASIC available	RF video signal, 64 by 16 characters, keyboard	Cassette		$1499 ($1649)	Keyboard in case. Has ten slots. Uses S-100 bus. (Price) includes video output. Parallel I/O available.
Altair 8800b	8 K	256			Cassette, Kansas City standard	RS-232C, TTY	$2080 ($2830)	Basic expansion mainframe. (Price) includes terminal (video and keyboard). Uses S-100 bus. Parallel I/O available.
MITS 300	64 K	256	Disk Extended BASIC	Video terminal (includes keyboard)	Dual 8 inch floppies		$7445	Uses S-100 bus. Parallel I/O available.
PolyMorphic Systems								
Poly 88 System 6	16 K	1 K	Assembler, 11 K BASIC on cassette	RF video signal, keyboard	Cassette		$1575 (k) ($1725)	In small mainframe. Cabinets plug together. Uses S-100 bus. (Price) includes video output. Parallel I/O available.
Poly-88 System 16	16 K	1 K	Assembler, 11 K BASIC	9 inch video display, keyboard	Cassette deck		$2250	Upgraded version of above. Uses S-100 bus. Parallel I/O available
System 16 (upgraded)	16 K	3 K	Monitor, assembler, editor, Disk BASIC	RF video signal, 64 by 16 characters	5 inch floppy		$3250 ($3500)	Mainframe system. (Price) includes keyboard, video output (both required). Parallel I/O available.
Processor Technology								
SOL-PC Single Board Computer	2 K	1 K		Keyboard, RF video signal		SIO, PIO	$745 $575 (k) ($1000)	(Price) includes power supply, video display. Uses S-100 bus.
SOL 20/16	16 K	1 K	Monitor, 5 K BASIC, Extended BASIC included	RF video signal, 64 by 16 characters, keyboard, 85 keys	Cassette, Processor Technology tape standard, 1200 bits per second	SIO, 2 PIO	$2850 $2095 (k) ($3000)	Keyboard in case. (Price) includes video display. Diablo Hytype printer interface available for $150. Uses S-100 bus.
SOL System III	50 K	3 K	Monitor, editor, BASIC, FORTRAN, 5 K BASIC	12 inch video display, 64 by 16 characters, keyboard, 85 keys	Dual 8 inch floppy drives; cassette	RS-232C, 8 PIO	$5995	Uses S-100 bus.
Quay								
Q80AI/TB	1 K	3 K	Monitor, Tiny BASIC			SIO	$425 ($1175)	Has two piggy-back boards. Uses Z-80 processor, S-100 bus. (Price) includes terminal (video and keyboard), power supply. Parallel I/O available.
8000	8 K							Same as above.
90 MPS-0	4 K	1 K	Monitor			SIO	$695 ($1445)	Expandable Z-80 system. (Price) includes terminal (video and keyboard). EROM programmer. Parallel I/O available.
Quest								
Super Elf	256	3 K	Monitor, Tiny BASIC	Keypad, RF video signal		RS-232C, PIO	$170 $145 (k) ($295)	Single board computer. (Price) includes video output. Uses 1802 processor.

Manufacturer and Model	Programmable Memory	Read Only Memory	Software	Terminal I/O	Mass Storage	Other I/O	Price	Comments
Radio Shack (Tandy) TRS-80 Level II	16 K	12 K	Monitor, Radio Shack Level II BASIC	Video output, 64 by 16 characters, 48 by 128 graphics characters (solid rectangles), keyboard	Cassette, 250 and 500 bits per second		$739 ($889)	System price includes Ithaca Audio 16 K memory upgrade. Level II BASIC in read only memory. Uses Z-80 processor. Parallel I/O available. Wide variety of software available.
TRS-80 "Professional"	16 K	12 K	Monitor, Radio Shack Level II BASIC	Video output, 64 by 16 characters, keyboard. Graphics same as above	5 inch floppy, cassette deck, 500 bits per second	PIO	$2385	Price includes printer, expansion interface. Uses Z-80 processor. Wide variety of software available. RS-232C optional.
TRS-80 Business System	32 K	12 K	Monitor, Radio Shack Level II BASIC	Video output, 64 by 16 characters, keyboard, graphics same as above	Dual 5 inch floppies, cassette deck, 500 bits per second	PIO	$3874	Comes with two printers and expansion interface. Uses Z-80 processor. Wide variety of software available. RS-232C optional.
Rank Peripherals 68101	1 K	256	J-bug monitor	Keypad, LED display	Cassette		$359	Single board computer. Based on MEK-6800 D2 evaluation kit.
RCA Cosmac	256			Switches			$195	Single board computer. Has power supply. Uses 1802 processor.
Cosmac Elf II	256	512	Monitor	Keypad, RF video signal		RS-232C, TTY, PIO	$275 (k) ($425)	Same as above. (Price) includes video display, power supply.
RDA Inc RD-11C	40 K		DECUS library software	Video terminal (includes keyboard)	Dual 5 inch floppies	RS-232C	$7975	Uses LSI-11 processor. DEC software compatible.
Realistic Controls Rex	48 K	1 K	Monitor, CP/M standard disk operating system	RF video signal, 80 by 24 characters, keyboard	Dual 5 inch floppies	PIO	$3665 ($3815)	Expandable. Has FORTRAN IV. (Price) includes video display. Uses S-100 bus.
Rockwell AIM 65 Printing Terminal	4 K	8 K	Monitor, text editor, disassembler, assembler, BASIC	Keyboard, 54 keys, 20 character display, printer	Dual cassette units	TTY, 2 PIO	$635	Single board computer. Has on-board printer. Power supply required (not included). Comes with assembler program. Uses 6502 processor.
SD Systems Z-80 Starter Kit	1 K	2 K	Z-bug monitor	Keypad, LED display	Cassette, Kansas City tape recording mode	2 PIO	$249 (k)	Single board computer. Contains EROM (erasable read only memory) programmer. Uses Z-80 processor.
Signetics Instructor 50	768	2 K	Monitor	Keypad, LED display	Cassette	PIO	$350	Single board computer. Education oriented. Uses 2650 processor. Comes in case.
Smoke Signal Broadcasting Chieftain I	32 K		Monitor		Dual 5 inch floppies	SIO	$2595 ($3345)	Business oriented mainframe system. (Price) includes terminal. Uses SS-50 bus, 6800 processor.
Space Byte Modular Software Development System	48 K	3 K	Monitor, assembler, business software packages	Hazeltine terminal (video and keyboard)	Dual 8 inch floppies	RS-232C	$6595	Has EROM (erasable read only memory) programmer. CP/M standard disk operating system available. Uses S-100 bus.

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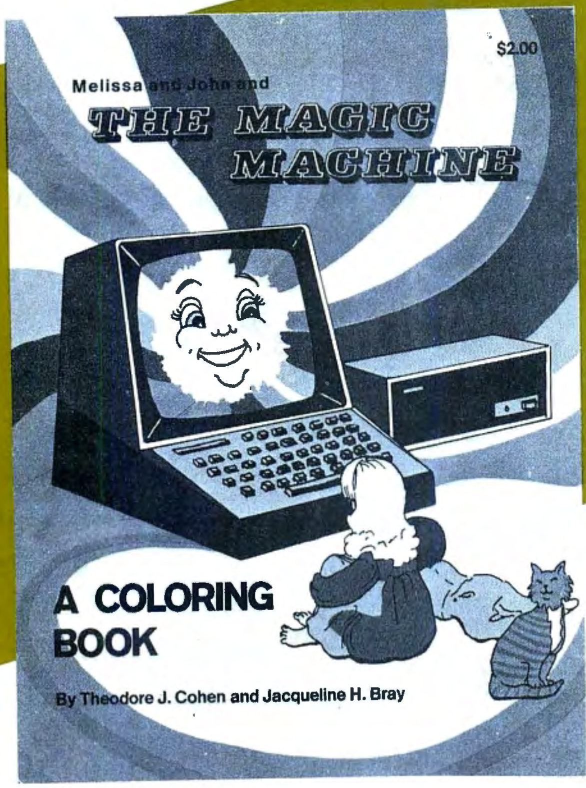
Manufacturer and Model	Programmable Memory	Read Only Memory	Software	Terminal I/O	Mass Storage	Other I/O	Price	Comments
Southwest Technical Products Corp								
6800/2	8 K		Monitor, BASIC available	RS-232C, TTY	Cassette	PIO	$595 $539 (k) ($1289)	Expandable mainframe system. (Price) includes terminal (video and keyboard). Uses SS-50 bus, 6800 processor.
System B	40 K		Monitor, BASIC	Video terminal (includes keyboard), RS-232C, TTY	Dual 5 inch floppies	PIO	$4495	Comes with CT64 video terminal. Uses SS-50 bus, 6800 processor.
Synertek								
Super Jolt	1 K	1 K	Monitor, Tiny BASIC available			PIO	$375	Single board computer. Uses 6502 processor.
VIM-1	1 K	4 K	Monitor	Keypad, LED display, TTY, RS-232C	Cassette 135 and 1500 bits per second	PIO	$269	Single board computer. Requires power supply (not included). Uses 6502 processor. BASIC and assembler packages available.
Tano Computer								
Outpost II	32 K		BASIC available	12 inch video display, 80 by 24 characters, keyboard	5 inch floppy	RS-232C	$1995	Parallel I/O available.
Technico								
Super Starter	512	1 K	Monitor			RS-232C	$399 $299 (k) ($1049)	Single board computer. Uses 16 bit TMS 9000 processor. (Price) includes terminal (video and keyboard). Various software available.
Texas Instruments								
TM 9900/101 M	1 K	1 K	Monitor			SIO	$625 ($1375)	Single board computer. Uses 16 bit TMS 9000 processor. (Price) includes terminal (video and keyboard), power supply.
Vector Graphic								
Vector MZ	32 K	12 K	Monitor, Extended BASIC		Dual 5 inch floppies, double sided double density	SIO, PIO	$3750 ($4500)	Mainframe system. Uses S-100 bus. (Price) includes terminal (video and keyboard).
MEM	24 K	1 K	Monitor, word processor, assembler, disassembler	12 inch video display, Diablo 1620 printer	5 inch floppy		$7950	Word processing oriented system.
Video Brain								
VS-101 with Expander 1 and VB 59 cartridge	1 K+	6 K	Super BASIC	Color RF video signal, television audio, keyboard, 36 keys	Cassette, read only memory cartridge	RS-232C, 2 joysticks	$800 ($1100)	BASIC available in programmable cartridge. (Price) includes video output.
Western Data Systems								
Data Handler with expansion board and 16 K	17 K	2 K	Monitor	RF video signal, 80 by 25 characters, keypad	Cassette, 24 bits per second	PIO	$817 $764 (k) ($1014)	Comes in wood cabinet. (Price) includes power supply, video output. Has parallel I/O. Uses S-100 bus.
Wintek								
Micro Module	16 K	1 K	Monitor	300/2400 bits per second	Cassette	2 PIO, RS-232C	$870 ($1600)	Assembler available. (Price) includes terminal (video and keyboard).
Xitan								
Alpha 4	17 K	2 K	Monitor, assembler, text editor, BASIC	RF video signal, 80 by 24 characters	Cassette	SIO, PIO	$1929 ($2179)	Mainframe system. (Price) includes keyboard (required), video display. Uses S-100 bus. ■



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Coming Events

May 23 through 24: The Clemson Conference on Small Computers: Application for Business, Industry, Education, Medicine,Clemson University, Clemson SC. This conference will include discussions on a wide variety of applications, tutorials on small systems and exhibits of equipment. Contact William J Barnett, Associate Professor, College of Engineering, Clemson University, Clemson SC 29631.

May 24 through 26: Computers in Critical Care and Pulmonary Medicine, Yale University School of Medicine, Norwalk CT. The purpose of this meeting is to bring together computer scientists, biomedical engineers and physicians who are interested in the application of computer technology in the diagnosis and treatment of critically ill patients. Contact S Nair MD, Norwalk Hospital and Yale University School of Medicine, Norwalk CT 06856.

June 3 through 6: 1979 International Summer Consumer Electronics Show, McCormick Place, Chicago IL. This show serves as the marketplace for the entire consumer electronics industry. Contact Consumer Electronics Show, Two Illinois Center, Suite 1607, 233 N Michigan Av, Chicago IL 60601.

June 4 through 7: 1979 National Computer Conference, New York Coliseum. NCC '79 will feature a showcase of the state-of-the-art in computing and data processing. In conjunction with NCC '79, a Personal Computing Festival of commercial exhibits, application demonstrations, and technical sessions on microcomputer systems and applications will be held at the Americana Hotel. Contact NCC '79, c/o American Federation of Information Processing Societies Inc, 210 Summit Av, Montvale NJ 07645.

June 6 through 8: Twelfth Annual Association of Small College Computer Users in Education Conference, Denison University, Granville OH. Sessions will include demonstrations of the educational use of microcomputers, computer textbook surveys, discussions with authors of computer texts, administrative uses of computers in small colleges, and a tutorial on microprocessors. Contact Douglas Hughes, Computer Center, Denison University, Granville OH 43055, (614) 587-0810.

June 19 through 21: International Micrcomputers/Minicomputers/Microprocessors '79, Palais des Expositions, Geneva, Switzerland. The 1979 conference program will probe advances in systems and equipment with emphasis on practical applications and uses of minicomputers and microcomputers.

July 16 through 27: Introduction to Digital Electronics and Microcomputer Interfacing, Lexington VA. This hands-on laboratory course will include approximately 60 hours of laboratory instruction with one microcomputer laboratory station for each two participants. Contact Prof Philip Peters, Dept of Physics, Virginia Military Institute, Lexington VA 24450.

August 8 through 10: First Annual Conference on Research and Development in Personal Computing, Hyatt Regency O'Hare, Chicago IL. A large trade show of personal computer and graphics equipment is planned to accompany an assortment of papers, panels, user group meetings, workshops, and person to person poster booths. Contact Bob Gammill, Computer Science Division, Dept of Mathematical Sciences, 300 Minard Hall, North Dakota State University, Fargo ND 58102.

August 19 through 22: International Conference on Computing in the Humanities, Dartmouth College, Hanover NH. This conference is intended to foster computer research and technique in all areas of humanistic study; to promote international cooperation in the development of programs, data banks, and equipment; and to make available the results of research. Contact Stephen V F Waite, Kiewit Computation Center, Dartmouth College, Hanover NH 03755. ■

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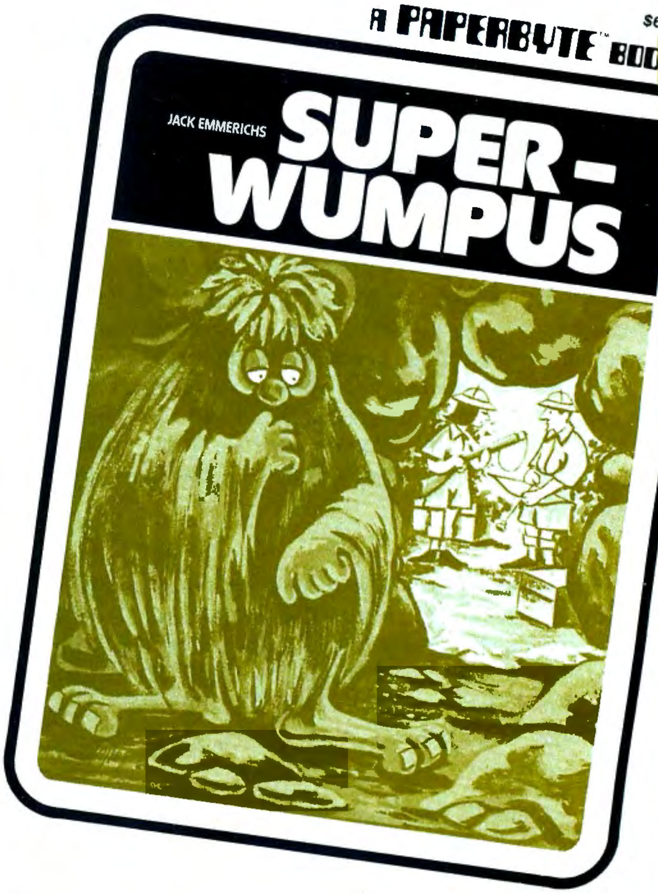

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The Information Age

by Theodore J Cohen

Photo by Bill Watkins

We are entering a new age, one which is best termed the Information Age.

Unlike its predecessor, the Machine Age, when such natural resources as minerals and energy were the raw materials which permitted humanity to extend its physical powers, the Information Age will see us extend our information processing and decision making powers to heights yet undreamed. In this new age, data will be the natural resource, and information, its refined product. And it will be those individuals, corporations and countries who master the acquisition, processing, storage, retrieval, transmission, and use of information — that is, those who control information — who will triumph in their endeavors.

What has brought us to the Information Age? What will be required in the way of technological advancement for us to prosper in this age? And what will be required of us if the potential of this new age is to be realized?

The Information Age could not have occurred without the technological advances which have been achieved since the middle of the 17th century. These technological advances are as much the cause of the Information Age as they are the key to its survival, for with these advances has come an information explosion which must be managed effectively if it is to benefit humanity.

Where once there existed a limited body of science known as natural philosophy, our knowledge of physical matter and its behavior has led to the development of such diverse fields as atomic physics, nuclear physics, plasma physics, and solid state physics. Similar subdivisions have also appeared in other scientific, technical, medical, and sociological fields, to name a few, creating a virtual blizzard of journals, reports, digests, and other types of records. Today, it is estimated that

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Theodore J Cohen holds advanced degrees in physics and geophysics from the University of Wisconsin, and has over 26 years of experience in the areas of communication and electronics. He currently manages the Advanced Technologies Branch of Tracor's Electronic Systems Division where, among other things, he is participating in the development of the technical bases for the 1979 World Administrative Radio Conference. A frequent contributor to the scientific, technical, and popular literature, he is probably best recognized for his work in the area of ionospheric radio wave propagation, and he has coauthored a recently published handbook on this subject. Dr Cohen, who lives in northern Virginia with his wife and two children, is now actively engaged in the preparation of books for children on such topics as computer fundamentals and robotics.

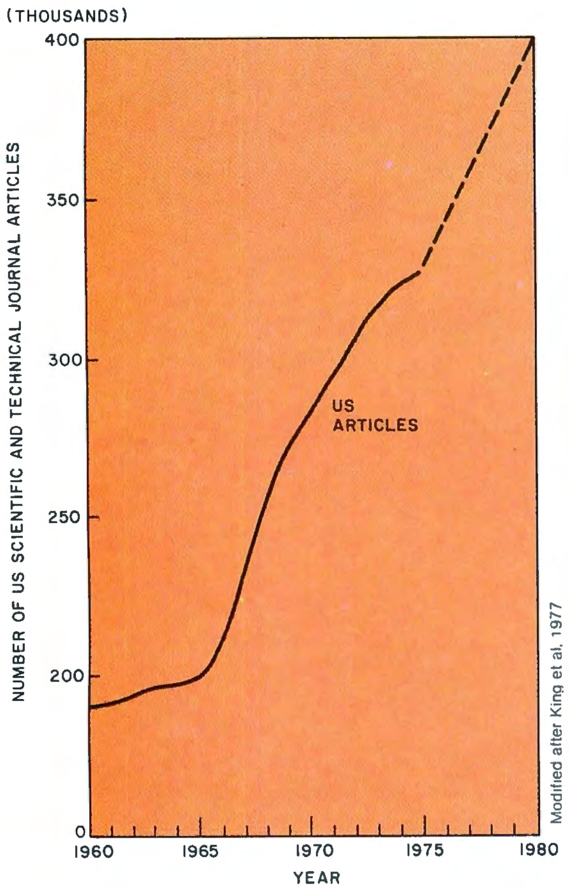


Figure 1: The number of articles published annually in US scientific and technical journals increased considerably between 1960 and 1975. This is due in large part to subdivisions within the scientific, technical, medical and sociological fields. It is projected that by 1980 the number of articles published annually will reach 400,000.

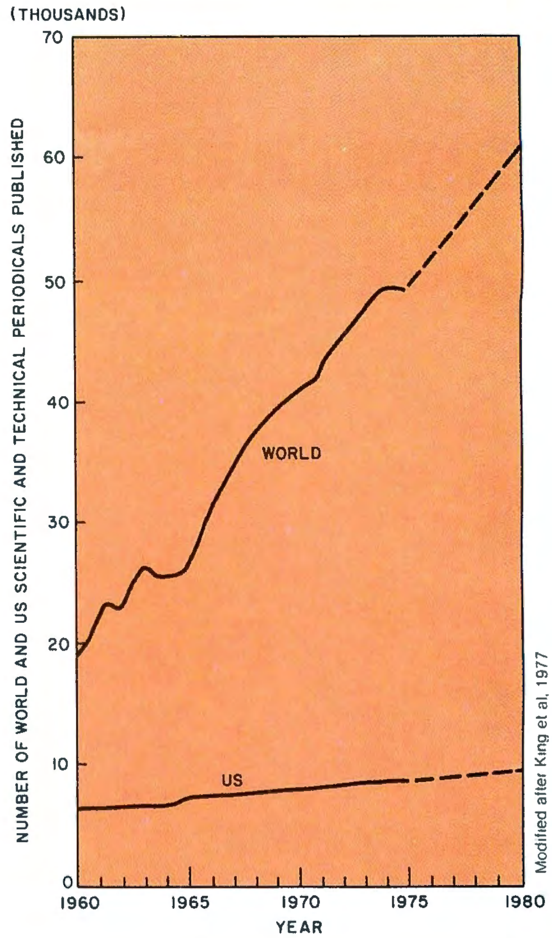


Figure 2: The US is not alone in technological advancement. As illustrated here, the number of scientific and technical journals published annually in the US and worldwide more than doubled between 1960 and 1975. It is estimated that by 1980 the annual number of such journals published worldwide will exceed 60,000.

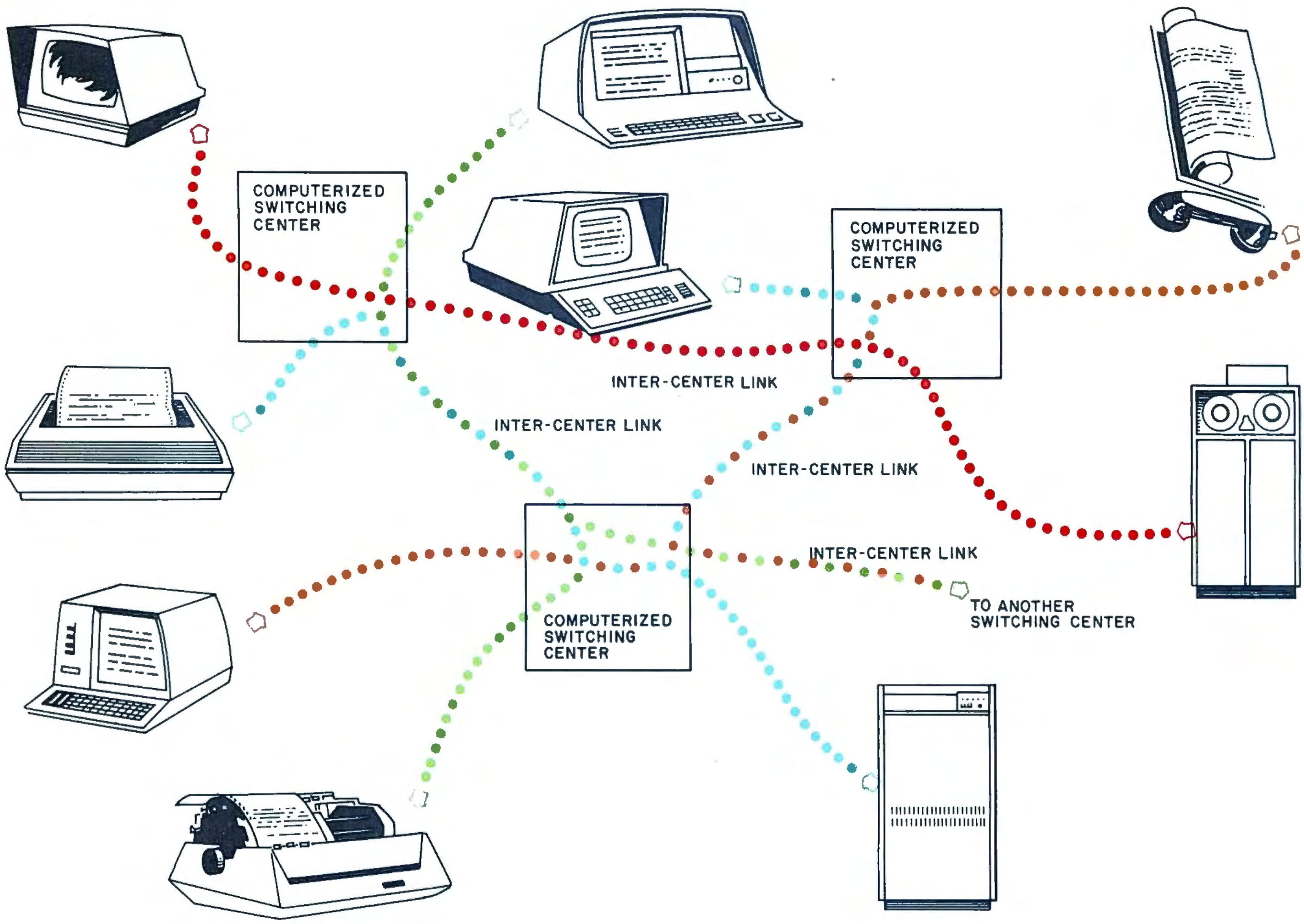
over 50,000 scientific and technical periodicals are published worldwide each year. Further, the annual number of US journal contributions probably exceeds 350,000, and is expected to reach 400,000 by 1980.

Consider, too, how the use of earth sensing satellites (Klass, 1977) has contributed to the information explosion. The currently used LANDSAT series of earth exploration satellites, for example, will shortly be joined in space by a variety of more capable systems which will be used for such applications as topographic mapping, mineral exploration, and crop forecasting. They will yield a volume of data which is almost beyond comprehension. Yet even today, researchers are able to use only a very small fraction of the data collected by earth sensing satellites. Thus users of the satellites find themselves in a position that can only be described as data rich and information poor.

Clearly, new techniques are required to encode, process and record information ... techniques which will speed the transmission, receipt, reproduction, and dissemination of this vital resource.

Since the transmission and receipt of information is critical to the Information Age, this age's communication requirements will be awesome. Norbert Wiener, the great mathematician, once said that, "Information is a name for the content of what is exchanged with the outer world as we adjust to it, and make our adjustment felt upon it."

If we substitute the word "communicated" for "exchanged," we see that every human endeavor, by this definition of information, necessarily involves one or more communication systems which are required to maintain relationships between an individual and the universe. Yet, before an individual can use information, other systems must



Modified after T Hanke, *Business Week*, November 6 1978

Figure 3: An advanced communications and control system of the type now being developed by the American Telephone and Telegraph (AT&T) Company. The use of digital information packets will permit many messages to be interleaved on the same communication link.

collect and convey raw data for processing, encode and store the resulting information, and retrieve and transmit this information to the individual for use.

In short, there can be no Information Age without communications.

This last statement is not trivial. We take for granted the basic tools with which we communicate: our senses. Yet, without the ready exchange of information between individuals, and between peoples, cultural impoverishment would result. One has only to witness the state of development of isolated tribes in Brazil and in Papua-New Guinea, for example, to observe that in many cases, their cultures have advanced little since the Stone Age. This is not to argue that life in the more industrially developed areas is necessarily better than life in isolated cultures. It is only meant to indicate that populations which are isolated from the mainstream of current thought and activity are "impoverished" by the standards we set today.

Isaac Asimov once identified the ability to communicate using electronic media as one of four landmarks in human history (the other three were when we learned to speak, to write, and to print with movable type). Today, in all areas of our private and business lives, the impact of communications and information transfer is being felt with greater frequency and intensity.

Through the development of electronic technology and the attendant large scale integration (LSI) of electronic components, we are now able:

- to communicate instantly, on a worldwide basis, using communication satellites;
- to transfer funds into, within, and out of a banking system;
- to execute conferencing between individuals, between individuals and computers, and between computers;
- to speed information transfer through the use of "electronic mail;"
- to store and manage large quantities of information for subsequent retrieval and use;

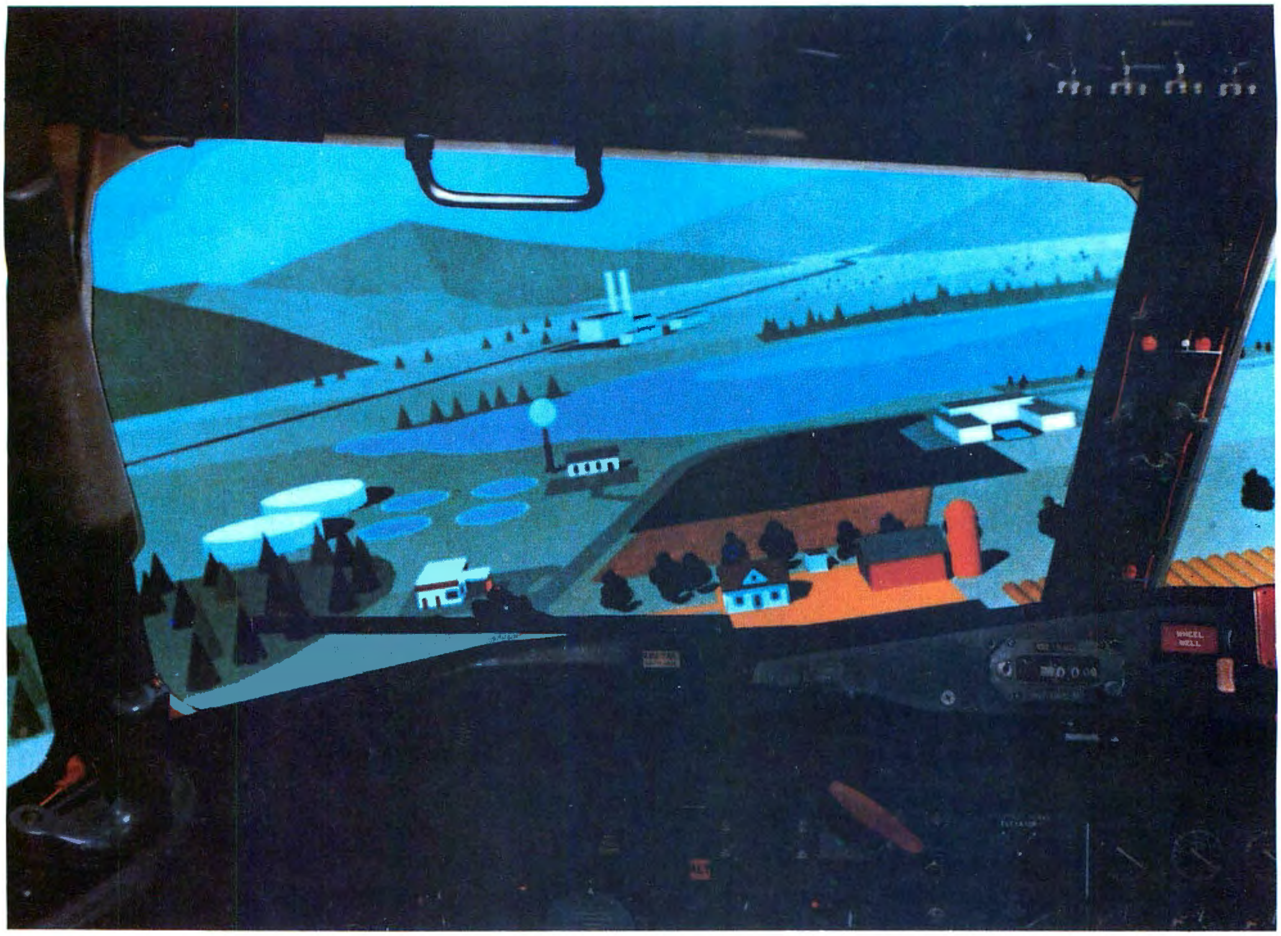


Photo courtesy of General Electric

Photo 1: This scene, which was generated in real time by a computer graphics system, shows a pilot's view of a landscape as it would be seen from the cockpit of an aircraft flying at a low altitude. Visual simulation, such as that shown here, is used by the military and commercial communities to enhance training effectiveness, to improve operator efficiency, and to reduce training costs. This scene was generated by General Electric's Compu-Scene system, one of the more advanced, all electronic, image generation systems produced today.

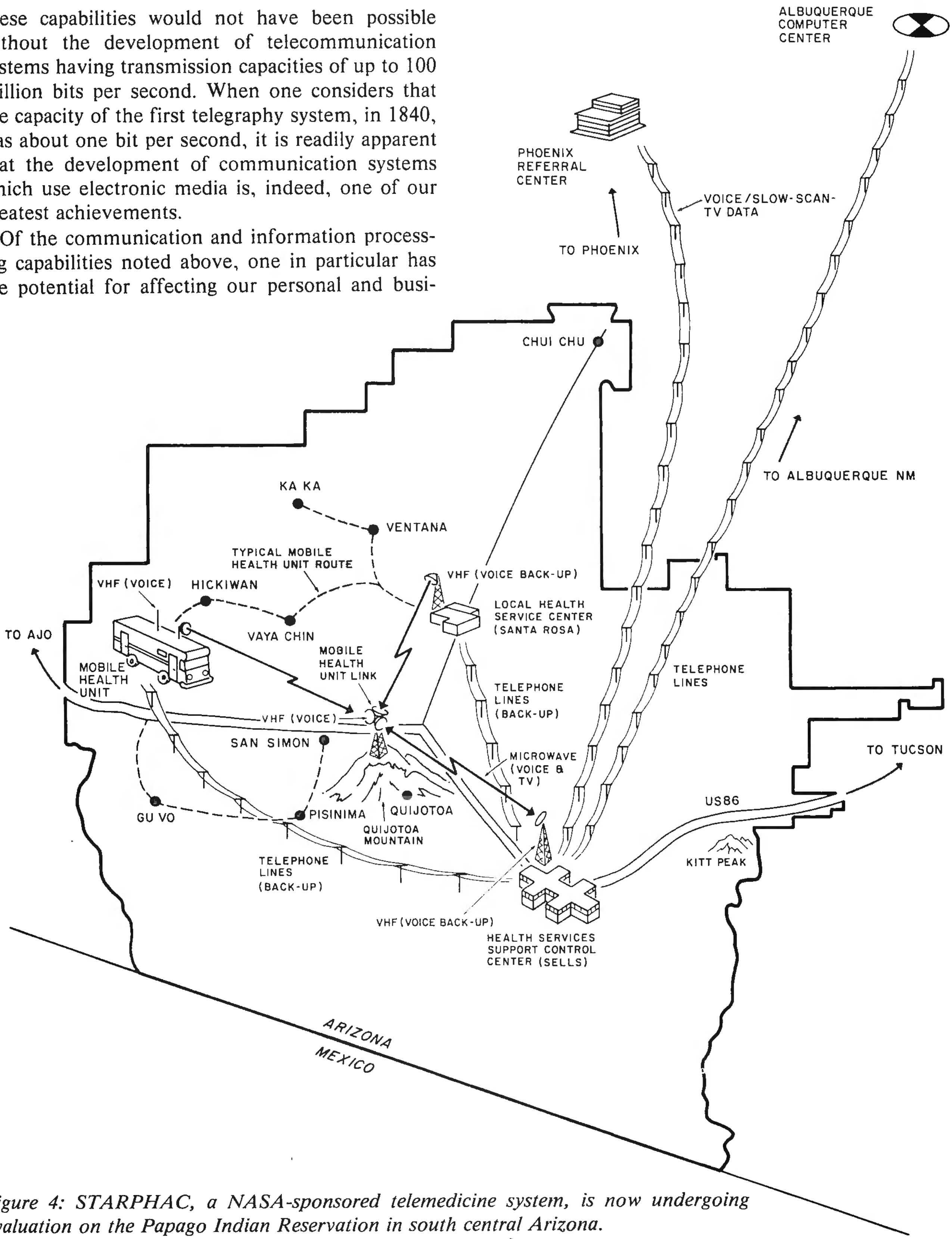
- to simulate sophisticated devices (for example, an aircraft cockpit) and the environments in which they operate;
- to automate design and manufacturing processes using "computer-aided-design" (CAD) systems;
- to perform air traffic control (ATC) using real time data acquisition and display terminals;
- to provide computer-aided instruction for educational purposes;
- to provide interactive audio and video telediagnosis (telemedicine) for emergency situations in remote locations;
- to play sophisticated games in our homes using computerized devices which are entertaining as well as challenging;
- to communicate directly with computers and machines using voice recognition systems;
- to receive information directly from computers and other devices by means of voice synthesis systems;
- to employ digital telephone switches and other systems which optimize the transfer of information;
- to impart a modicum of intelligence (albeit artificial) to machines and other devices (robots) for use in such areas as computer-aided manufacturing;
- to employ multiple access communication systems which permit numerous exchanges to be made simultaneously in the same frequency band;
- to communicate by radiotelephone from vehicles in motion at sea, on land, and in the air;
- to type, revise, and retrieve information quickly from electronic typing and editing systems.

These and many other examples of today's communication and information processing capabilities testify to our abilities to exchange information with one another, as well as with machines. Yet some of

When one considers that the capacity of the first telegraph system, in 1840, was about one bit per second, it is readily apparent that the development of communication systems which use electronic media is, indeed, one of our greatest achievements.

these capabilities would not have been possible without the development of telecommunication systems having transmission capacities of up to 100 million bits per second. When one considers that the capacity of the first telegraphy system, in 1840, was about one bit per second, it is readily apparent that the development of communication systems which use electronic media is, indeed, one of our greatest achievements.

Of the communication and information processing capabilities noted above, one in particular has the potential for affecting our personal and busi-



Modified after Allan, 1976

Figure 4: STARPHAC, a NASA-sponsored telemedicine system, is now undergoing evaluation on the Papago Indian Reservation in south central Arizona.

ness lives significantly. This one is known as "computer conferencing."

Arthur C Clarke, who wrote *2001 — A Space Odyssey*, has for years admonished his readers: "Don't commute — communicate!" In the Information Age, this thought will be realized through advanced communication and control systems which will serve multiple users employing a variety of equipment (eg: keyboard terminals, graphic displays, computers, etc). Such advanced communication systems, which will be worldwide in their coverage, will continuously monitor terminals for demand access. They will determine the best method by which to link two or more terminals and/or central processors together, and will monitor network performance so as to take action in the event that service on a link deteriorates below a predetermined level of performance.

The advantages in using such systems are many. Perhaps most important is the fact that computerized conferences using advanced communication systems will be able to support meetings that will be "attended" by individuals who may be separated by thousands of miles. No one has to leave his or her office, and in many cases, participants will work in their homes, using a standard telephone line to link their terminal to the computerized conferencing system. With more than half of the workforce in the United States now engaged in information or communications activities, the potential for making more effective use of a worker's time through computerized conferencing is staggering.

But there are other advantages to computerized conferencing, many of which are quite subtle. Turoff and Hiltz (1977), for example, observed that when using computer conferencing, more people participate in the exchange; that is, situations in which a few people might otherwise dominate a face-to-face meeting are defused. In addition, groups using computer conferencing tend not to dwell on a given topic, but instead, cause the exchange to range over a variety of pertinent subject areas. Finally, there is less pressure to reach last minute decisions since the time that would be used for travel can now be used more effectively for analysis of the problem at hand.

Computerized conferencing is not the answer to all conferencing problems, however. In some situations, face-to-face contact is simply a necessity; these include situations where matters of a personal nature are being discussed, where a group must physically be together under a strong leader, or where delicate negotiations must take place. Further, it is not altogether clear that easy access to individuals in their homes and offices, through the use of computerized conferencing systems, is necessarily desirable at all times because of the interruptions such a system will cause in other activities. Even today, the telephone all too frequently forces users to stop their activities to respond to the calling party. Further, with users of conferencing systems accessible in their homes and offices, when will people be able to "get away from it all"? When will the individual have time to reflect on activities, and on the larger implications, of his or her work?

Some answers to these questions will probably come from a multitude of future studies on "human factors and computer conferencing." But while social scientists wrestle with such problems, it is safe to assume that in the Information Age, life will change to accommodate new techniques for information exchange. Given this fact, we must begin to consider now how our lives may change, lest we face the shock of entering the Information Age without the necessary technical and psychological preparation.

Consider, too, how the exchange of information on a timely and comprehensive basis will be of increasing importance to military commanders, and specifically, to the battlefield commander. The latter, among other things, must have a means by which to display all of the information which is available so that all of the factors which bear on any given situation can be taken into account. Given this requirement, information displays, and in particular those which employ color imaging, will take on added importance in the Information Age. This point was noted by Eberhardt Rechtin, who, in his keynote address to the 1978 IEEE Eastern Conference (EASCON), said:

> *"We now have military displays which show friendly, neutral and enemy forces in different colors on the same display. Rapidly being added to these displays are cues for some of the special characteristics of the objects being displayed such as vector direction, vector velocity, and armament range. We could go further and indicate probable fuel reserves, indicate which elements were just put out of action, and indicate which moves are potentially threatening or counterproductive. By extending the ideas of pattern recognition and bringing in the principles of warfare, we might be able to visualize the strategic intentions and possibly predict the future actions of either or both sides."*

Dr. Rechtin added that this same display capability could be used to visualize the spread of diseases in the human body or within a population, or to visualize the dynamic performance of transportation and logistics systems, as well as to monitor and control a network of communication systems. In short, he concluded that during the

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Many nations fear that they will be overwhelmed by the media from developed countries, and so, they are seeking to erect protectionist barriers to the free flow of information.

Information Age, "the expression, *I see,* will have a meaning only dimly perceived today."

It may be postulated that our ability to amass information and to communicate is a direct result of our technological state of development. Conversely, it may be postulated that this state of development is a prerequisite for our continued development in the Information Age. If these postulates are valid, we reach the somewhat disconcerting conclusion that not all societies are prepared for, nor are they capable of participating in, the Information Age. This, in turn, suggests that there will be a significant level of conflict between those societies which are technologically positioned to embrace this new age, and those societies which are struggling to reach a state of preparedness.

That this dichotomy exists is readily apparent when one considers the gulf which exists between the so-called developed countries and the less developed countries. It is not surprising to find that the less developed countries are increasingly concerned about the flow of information across their national borders. Simply put, many nations fear that they will be overwhelmed by the media from developed countries (Kroloff and Cohen, 1977), and so, they are seeking to erect protectionist barriers to the free flow of information. This philosophy sanctions government control of information, including the media, and as a result, we are already witnessing a decline in the amount of information which is available to us from certain countries.

In commenting on this, Stanley Meisler (1978) recently noted that "the Third World is harassing foreign correspondents more and more. In some areas, a virtual news blackout exists," and today, "ministries of information (in Third World countries) react to stories they find displeasing by admonishing, expelling, or jailing correspondents" (Meister was expelled from Zambia in 1970 because an official there took offense at an article he wrote on that country). So prevalent are the problems in covering the Third World that Philip Foisie of the *Washington Post* once noted: "The world is closing down around us" (Kroloff and Cohen, 1977).

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The world is also closing *in* around us! The immediacy of the news media now brings a multitude of disasters and tragedies to the breakfast and dinner table. Whether one opens the pages of a newspaper to see pictures of a morgue in the Canary Islands following an airline collision, or of bloated, rotting bodies lying on the ground in Jonestown, Guyana, we are constantly bombarded with distressing news from all over the globe. As a result the negative news which reaches us stretches our physical and mental capabilities to absorb and resolve those matters which directly and indirectly impact on our lives. Perhaps all that is news is not fit to print, and the western world's current emphasis on violence in the news will have to be tempered by a realization that as more and more material becomes available, people will seek only that information which is enlightening and of benefit to them.

With respect to the need for a universal acceptance of information exchange, and given the benefits which could accrue to such an exchange — benefits such as improved relations between the peoples and governments of the world, and enhanced opportunities for international development of trade — it is surprising, if not shocking, to find that the United States has no policies on many of the major issues which will confront us in the Information Age. In fact, consideration is yet to be given by our government to the need for a coordinator or a central clearinghouse for information policies of an international nature (Kroloff and Cohen, 1977). Further, many administrators and US officials are unable, in many cases, to recognize important relationships between diverse subject areas which eventually must be addressed in a comprehensive policy statement on information and communications.

Consider, for example, the forthcoming World Administrative Radio Conference (WARC) to be held in late 1979. The WARC, in its deliberations on the technical and operational telecommunication standards and operational procedures to be used through the year 2000, will, among other things, address the question of the use of broad-

Before an individual can use information, other systems must collect and convey raw data for processing, encode and store the resulting information, and retrieve and transmit this information to the individual for use.

Clearly, new techniques are required to encode, process and record information . . . techniques which will speed the transmission, receipt, reproduction, and dissemination of this vital resource.

casting satellites, and the transmission of information by these satellites to people on entire continents. One may reasonably ask how the matter of broadcasting satellites relates, say, to the question of how much information about an individual should be stored in a central data base, or to questions related to the free flow of information between individuals, corporations and countries. The answer is that all of these matters are related to the central question of how the availability of information will or should shape interpersonal and international relations in the Information Age.

Finally, in the Information Age, there is the danger that with the efficient exchange of information, and with virtually everyone able to work from the same information base, theories and opinions which are contrary to commonly held beliefs will meet with ever increasing opposition. Eventually, those individuals with unique approaches to a problem may become reluctant to voice their views, and so, valuable insights may be lost.

Classical examples of intolerance to new concepts and ideas include early opposition to Charles Darwin's theory of evolution, and to Alfred Wegener's hypothesis on continental drift (the latter being an early formulation of the plate tectonic theory, which is now almost universally accepted). However, even today, we often find it difficult to open our minds and to give consideration to new theories and hypotheses which deviate from the norm. Such narrowminded thinking will be the bane of the Information Age.

Yes, we are entering the Information Age, an age which will see humanity extend its information processing and decision making capabilities to the greatest heights ever achieved. Life in this new age will be challenging, exciting, mind expanding and rewarding. And, as you might expect, many changes will occur in our life styles at home and at work. These changes, however, will be evolutionary, in nature, rather than revolutionary. As such, there will be time to embrace those technologies which will permit us to control information, and in doing so, to control our destiny.

This is the promise of the new age . . . the Age of Information.■

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Computer Clubs Who Needs Them?

by Lloyd and Debbi Kishinsky

If you don't understand some of the theory, can't get your cassettes to read properly, can't get your programs to run, need help in designing a circuit, want to see the hardware in action before shelling out your hard earned bucks, want to develop a new high level language — help is always available.

It all began one typical Friday afternoon when I joined a group of coworkers for one of those infamous three martini lunches. We were all contemplating a glorious weekend, when Steve caught me off guard by asking, "Lloyd, when the hell are you going to break down and stop stashing all that loot you collect every week and go out and buy yourself a computer?"

Now Steve was a special case because he was a tinkerer from way back. Steve never threw away anything. His cellar contained every electronic circuit and component that he had been able to get his hands on since grammar school days. Dusty cardboard boxes hidden under the counters contained such treasures as his first audio amplifier (original design of course), vintage vacuum tubes dating back to Atwater Kents, salvaged power transformers, assorted resistors and capacitors and some of the first transistors ever sold. Steve had become involved in personal computing at its very inception and proudly showed off his first BYTE plus the original mailer to all friends and guests who visited his cellar.

His first computer kit featured an 8008 microprocessor and eight front panel switches as the only means of entering programs. He has since graduated to a Z-80 system with 64 K of programmable memory, dual floppy disks, a video display terminal, printer, and graphics display.

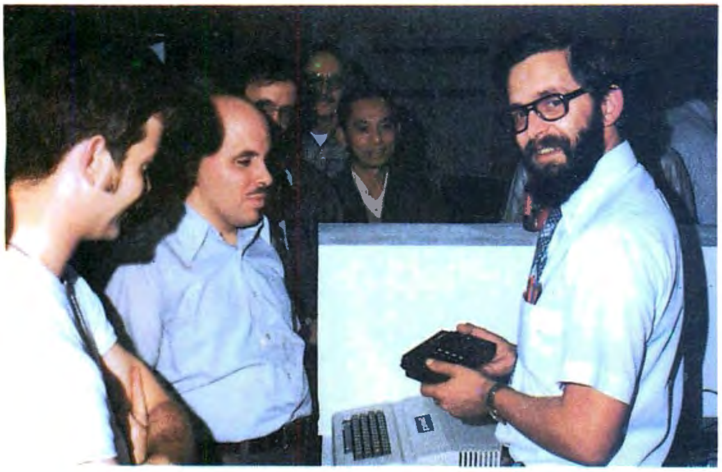
Up until the moment he confronted me in the restaurant, I was only an observer to his world of home computers. My involvement with computers had always been confined to my place of employment. But now as I gave it some thought, I realized I could no longer resist. All I was doing with my spare time was playing tennis, going skiing, watching Saturday, Sunday and Monday football and boozing it up with the guys after work.

Having made the decision, I submerged myself in researching the field. I studied all the catalogs, visited all the computer stores within a 50 mile radius and called up the chief engineers of the various companies. After weeks of intensive research, I disregarded all the facts that I had gathered and went out and bought a microcomputer system in kit form, identical to Steve's.

Things went along quite smoothly at first. I spent endless hours soldering the little integrated circuit sockets and components into the printed circuit boards. As soon as each board was completed, I would scamper over to Steve's house and plug it into his system for a test. Using this technique, I had my computer up and running in approximately five weeks.

I felt like the proud father of a newborn baby. My friends and family were charmed by the magic my computer and I were capable of performing. I kept all the kids on the block entertained with computer games. I spent endless happy hours refining my system ... and then it happened. One morning, Steve came into my office and informed me that he had accepted a position with another company and would be moving in two weeks.

I was panic stricken. I felt like a babe in the woods, defenseless against the complexities of the computer world. I didn't know where to turn. Luckily, a few days later a firm and reassuring voice came to me from above. Don, who worked in a department on the second floor, called to ask if I'd be interested in attending a meeting



Steve Dresser telling Ray Archer about the features of his talking calculator. An interesting note on the potential applications of small computers is the fact that Steve Dresser is blind.

Steve Dresser programming an Apple and using Morse code to determine whether the code has been entered properly.

Leo Taylor and John Shelley reviewing the schematic of John's computer and discussing a problem with the video interface.

John Shelley explaining the signal flow of his SD Sales Z-80 computer.

Linda Pro explaining some of the techniques she has developed to keep the interest of preschoolers during learning situations, using the Apple II with color graphics.

Leo Taylor demonstrating the use of his 6800 computer.

Photos by Lloyd and Debbi Kishinsky

Sign found in Greenville NH, mill town, population 1720

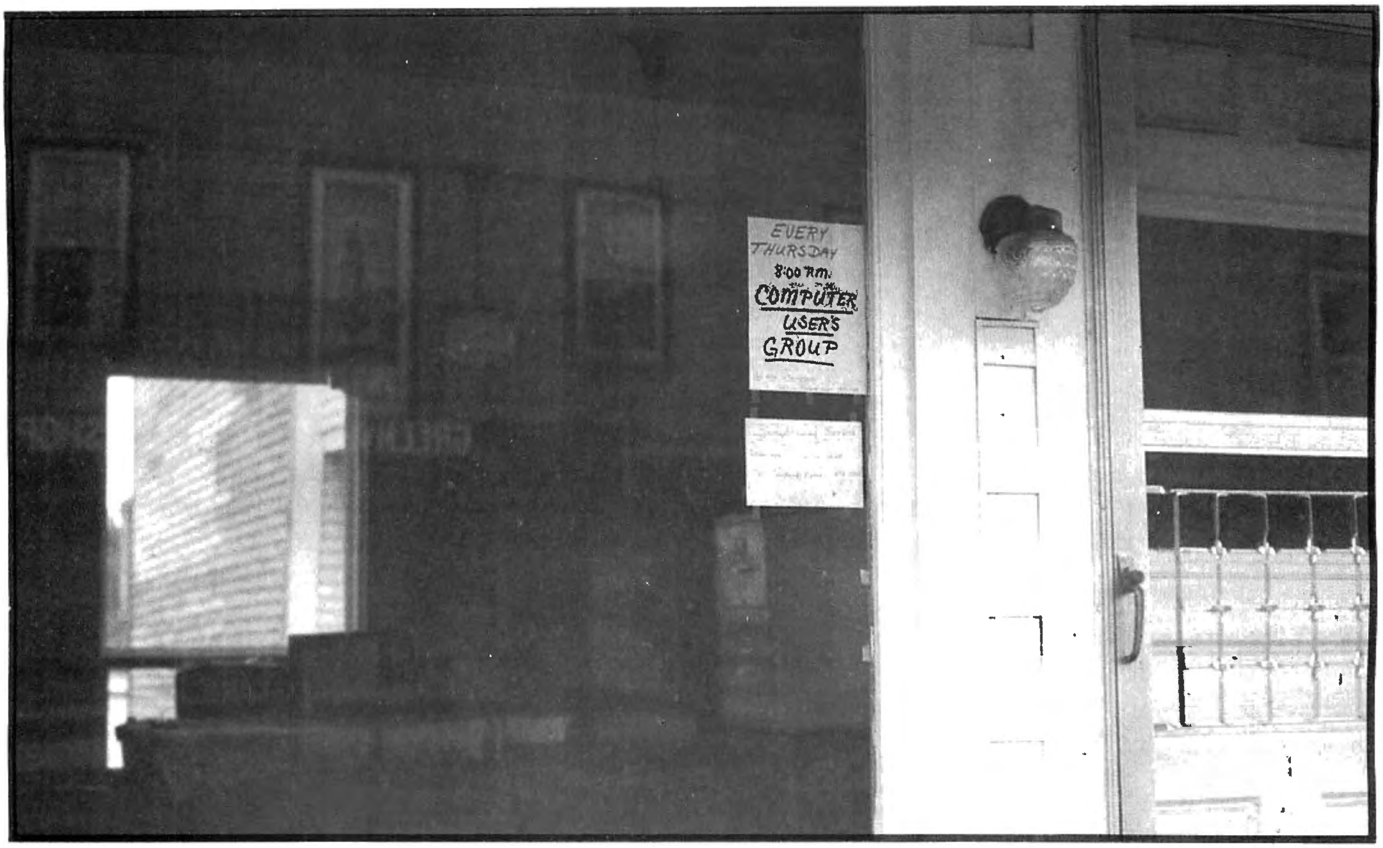


Photo by N Salmon

of the local computer club that Thursday night. He said that he had been to a few meetings and had met a number of interesting people. I accepted the invitation and after that first meeting I realized that I could now count on these people to fill the void left by Steve's departure.

The Connecticut Computer Club (CCC for short) was started in the fall of 1976. Approximately 15 members gathered at the new computer store in South Windsor on the first Thursday of each month to discuss the many aspects of their new hobby. The members ranged from systems analysts to students, engineers to amateur radio enthusiasts. All were involved in some way with computers or electronics as part of their jobs.

In those early days, homemade microcomputers, Altairs, IMSAIs and other microcomputers in kit form, were all the rage. Of course, there's always one killjoy in the crowd. Every once in a while, Bruce would bring an IBM 5100 to the meetings. Bruce is a consultant who travels about the country writing programs for the banking industry, carrying his prize possession from place to place. I still don't understand how it is possible to get a 24 by 80 display that is crisp and clean on a 5 inch screen. I'm having trouble deciphering a 16 by 32 display on my 9 inch television screen.

The original group of 15 has now grown to over 60. Surprisingly, the membership has remained basically the same in that most of the members are interested in microcomputers strictly as a hobby. Few executive types planning to utilize the computer as a means of simplifying their paperwork in business or at the office are to be found. Perhaps the individual who considers the computer strictly as a business tool can obtain all the information he requires at one of the many 3 day seminars that are advertised in the media.

For the first year and a half, all the club meetings were held at the computer store. As the group grew in size, it became more and more difficult to hold the attention of the members for more than five minutes at a time due to the lack of adequate seating. There were just too many distractions. The walls and shelves were lined with the latest books and magazines, circuit boards and wiring kits, components, tools, cassettes containing all the latest games, computers, printers, and graphic displays. The members were eager to examine everything! Finally, a proposal was made to change the place of the meetings to the local library even it it meant having to

pay for the conference room. The proposal passed, but I must admit I miss standing around talking to my friends, surrounded by all the goodies.

Two talks are normally scheduled for each meeting, one hardware oriented and the other software oriented. Members are requested to volunteer as speakers and tell about their latest accomplishments. Some of the topics that have been covered include electronic music, FOCAL, floppy disk systems, programs to entertain preschoolers, APL, troubleshooting techniques, etc. From time to time guest lecturers are invited to come in and demonstrate the latest in microcomputer hardware and peripherals. Special interest groups have also been formed and meet at members' homes on weekends. Classes are held in assembly language, BASIC programming and operating systems. Subjects such as these are best taught in quiet surroundings and with small numbers of people.

One of the things I like best about the club is the air of informality. I find that I can talk to other computer enthusiasts without having to defend my choice of hobby. How can you describe to a nonbeliever the joy of working on a program until 2:30 in the morning? Steve, Ray, Don and Linda would understand but not one of your neighbors, friends or relations would have the faintest idea of the thrill you get when, after all the hard work, your program finally runs without a hitch.

The varied backgrounds of its members is another of the club's strong points. If you don't understand some of the theory, can't get your cassettes to read properly, can't get your programs to run, need help in designing a circuit, want to see the hardware in action before shelling out your hard earned bucks, want to develop a new high level language — help is always available. The club counts among its members engineers, technicians, systems analysts, teachers, designers, service reps, college professors, writers, hams, musicians, doctors, and so on.

How can you describe to a nonbeliever the joy of working on a program till 2:30 in the morning?

I discovered how truly valuable my club membership was when I started a project to interface an IBM Selectric Model 731 to my microcomputer. One of my coworkers asked me if I'd be interested in buying a few well-worn Selectrics that were being phased out by a local company. Of course I jumped at the chance! When I got the units home, I took the best of the lot and got it in working condition by scrounging parts from the other machines. I brought the finished product to the next club meeting and gave a short talk and demonstrated how IBM had converted the basic typewriter mechanism into a computer input/output (I/O) device. Before the end of the evening, I had sold the first unit.

At this juncture, a small revolution was started by some members of my family. My daughters steadfastly refused to allow a typewriter in the house that typed upper case only. What would their teachers say?

For weeks, I searched for the type ball that would print both upper and lower case and match the keyboard of the binary coded decimal (BCD) machine. Calls to IBM offices all over the country turned up empty. The local office had no knowledge of a Model 731 let alone a BCD code. Where did I finally find the right information . . . at the computer club, naturally. One club member who had listened to my talk at the previous meeting had been so impressed with the possibilities of Selectric as a hard copy device that he went out and bought one. Fortunately, his unit came with the little round beauty I had been searching for. It was P/N 1167948. That number is now indelibly etched in my memory along with my social security number, my Army serial number and my wife's birthday. I had satisfied my daughters but then found that I needed an ASCII keyboard that supported both lower and upper case.

My original keyboard was from a Sander's Associates 720 terminal that I had purchased surplus. The unit was vintage 1970 and used a diode matrix to generate the ASCII code. No matter how hard I tried to make the necessary modifications, the combinations of keys and switches necessary to get upper and lower case plus carriage return, back space, escape and Control M were too much for me to remember. I passed the word around, scanned all the magazine ads, and combed the flea markets but none of these endeavors proved successful. Where did I get the lead that led to my new addition . . . you guessed it. There was a member who had a friend who had a keyboard for sale that was perfectly suited to my needs. All I had to do was put it in a case, add eight pull up resistors and inverters and make up a cable. Again, all the brainpower and sources of material came from the club members I had met.

Some members of the general public may envision the personal computing enthusiast as an anti-social individual who prefers to spend hours upon hours working alone in front of a machine. But in actuality, a computer group provides an invaluable opportunity for the enthusiast to get together with other people who share a common interest. The exchange that takes place at computer club meetings sheds light on areas where you might wander in the dark for months on your own.■

Continued from page 11

. . . if you can foresee a need to expand your computer system, be sure the system you choose can be expanded in the ways you need.

can be a poor choice. More and more of them are being sold as complete packages with little or no provision for altering or expanding the system. This is perfectly satisfactory if you don't anticipate a need for more than the initial package includes, but if your needs for memory or peripheral devices expand, you may be disappointed. Also, the sketchy documentation accompanying some fully assembled systems might make it pratically impossible for you to perform any modifications. Here again, it is vital to have a clear idea of what you want to do with the computer before you buy it. Many applications can be handled perfectly well on a package system and will never require any additional capabilities. If this is true of your application, you've nothing to fear; but if you can foresee a need to expand your computer system, be sure the system you choose *can* be expanded in the ways you need.

For many people, a fully assembled system will be the answer. It almost always carries a stronger warranty than a comparable kit, and eliminates electronics expertise as a prerequisite for enjoying computing. If you choose this alternative, you needn't do anything more technically complex than plugging in a power cord. You can start using the computer immediately. Whether your interest is games, program development, or an application (like accounting) in which the computer's calculations are more important than the type of computer that does the job, you can begin without delays for construction and checkout. This is the major benefit. The success of recently introduced package systems, which offer all the elements of a minimal system in an attractive case, testifies to the number of people who find this approach the most convenient one.

Several sorts of computers are currently available. Let's look briefly at the options to see whose needs they best suit.

One Board vs Mother Board vs All-in-One

A *one board* processor is exactly what it says: a single printed circuit card containing all the essentials of a processor and, sometimes, a complete minimal system. It does not have a case and generally does not include a power supply, which converts line current into the form required by the board's components. In this class, two examples are the KIM-1 and the Technico 9900 (see photos 1 and 2).

A single board microcomputer fills several needs well. It is usually inexpensive, often includes enough for a person who wants to get started in computing, and is almost always expandable. Thus, as the user's needs grow, the system can grow. If you're interested in process control applications, a one board microcomputer may be well suited to your needs, since it is usually fairly small and can be extremely powerful. The Technico 9900, for instance, is a 16 bit processor (not the 8 bit processor commonly found in personal computing) and it relies on a unique architecture which makes it one of the most powerful and versatile machines available.

But single board computers have the defects of their advantages. Expansion, while usually possible, generally requires electronics know-how on the part of the user. Also, the built-in input and output (I/O) facilities may be so limited by the board's size that they are unsuited to many applications, requiring the user to invest in additional I/O devices. A one board microcomputer can be an admirable choice for the experienced electronic hobbyist, especially if there's a project requiring a microcomputer in the background, but is usually a poor selection for anyone who is uninterested in the hardware side of computing.

At the other end of the spectrum is the all-in-one computer, exemplified by the Radio Shack TRS-80, the Exidy Sorcerer, the Commodore PET and the Apple II (photos 3, 4, 5 and 6). Here, in a single package, you get everything you need for a more than minimal system. Usually such systems include a video display for output, a keyboard for input, and a built-in audio cassette interface for entering or recording prewritten programs for future use. Unlike many earlier home computers, the all-in-one systems frequently have a higher level programming language (such as BASIC) available in read only memory, so that the moment the computer is turned on the user can address it in an easy-to-read language. Systems of this sort are an excellent solution for those who must fit their home systems into a limited space.

The primary use for the all-in-one system is entertainment. If your major reason for wanting a computer is to play games with it, one of these systems may be perfect for your needs. The PET even includes on its keyboard some graphics characters suitable for use in game playing. When the system has enough memory, all-in-ones can also be appropriate for program development and

small business applications. Compact and attractively packaged, they provide with a single purchase the essential computer needs — and for many people, that's a strong argument in their favor.

The major drawback to buying an all-in-one system is loss of flexibility. As mentioned above, with regard to fully assembled systems, expansion can be impossible or extremely difficult, especially on all-in-one fully assembled systems. Overall, they tend to limit your options, for even if an all-in-one system makes available a peripheral device you need as an add-on, it may not suit your specific application. For example, the print quality of the printer may be too poor for your application. This is the main thing to watch out for in choosing an all-in-one system. If you expect to use it solely for an application for which it is well suited and can foresee no need for additional memory, I/O, etc, beyond its limits, it is probably the system for you. Otherwise, you might be well advised to keep looking.

A middle ground between one board microcomputers and all-in-one systems is the class of personal computer I have roughly characterized as *mother board* computers. Mother board is the name given to the card in these systems into which all the other cards of the system are plugged. Examples of systems of this sort is the Southwest Technical Products (SwTPC) 6800, shown in photo 7. The mother board contains connectors wired together in such a way that a card plugged into any of them can be contacted and used by the processor. In some arrangements only certain slots can be used for certain purposes (so many slots for memory, so many for interfaces to external devices, and so on), while other arrangements permit any card to be plugged into any slot. This approach is quite often used in commercial minicomputers — the next step up, you might say, from personal computers.

A single board microcomputer fills several needs well. It is usually inexpensive, often includes enough for a person who wants to get started in computing, and is almost always expandable. Thus, as the user's needs grow, the system can grow.

Unlike many earlier home computers, the all-in-one systems frequently have a higher level programming language (such as BASIC) available in read only memory, so that the moment the computer is turned on the user can address it in an easy-to-learn language.

There are a lot of good systems out there and if you haven't found the right one, it doesn't mean that the right one doesn't exist. You just may not have found it yet.

The benefits of this arrangement are numerous. Most important, perhaps, expansion is allowed for in advance. You can buy the computer with only as many printed circuit cards as you need (eg: the processor card, some programmable memory, and one external interface), then add cards as your needs expand. Even if you fill the mother board, there is usually a straightforward way in which you can add an additional mother board to the system. Thus, there are very few applications for which a mother board system is not satisfactory. Add to this the fact that most mother board systems can be conveniently interfaced to a wide range of peripheral devices produced by many manufacturers and you have an impressive set of capabilities.

This very versatility, however, is responsible for the major disadvantage of mother board systems. The fundamental system sold is the computer itself — you must purchase the I/O devices (video display, keyboard, printer, etc) and external storage devices (cassette recorder or disk drive, for instance that you want separately. True, this assures that each part of your system is exactly what you need, but it can also drive up the price of the system as a whole. For the maximum flexibility and the ability to compose your system of precisely the components you need, a mother board system is hard to beat.

Enough of the systems on the market today are available both in kit form and fully assembled so that you can choose the approach most appropriate to your situation. In general, however, the following three guidelines will help prevent the anguish of discovering you've made a costly mistake.

The first is: *take your time.* Try to avoid making a hurried decision. There are a lot of good systems out there and if you haven't found the right one, it doesn't mean that the right one doesn't exist. You just may not have found it yet. If you think you're being fast-talked by a computer store salesman, don't make a purchase decision until you've gotten away and compared the facts. If the system is as good as the salesman says, it may be what you need; but be sure first that it's good for *your* purpose, not somebody else's.

The second guideline is: *see, handle, and preferably try out the system before you buy.* Most vendors are happy to demonstrate their wares and your local computer store may be able to let you perform back to back comparisons of several computers. Something that looks good in an advertisement may turn out to have severe defects when tried out on your application. This is another safeguard against buying a pig in a poke.

The third guideline is: *find someone who owns one* if at all possible. If there's a local computer club, this is a good place to look. This not only lets you find out if any problems with the machine have come up, but gives you someone to turn to with questions about the system both before and after you buy.

Input and Output Devices

The part of the system you'll see the most of is the device used to let it communicate with you. It makes sense, therefore, that this part of the system be chosen with special care. Also, your particular application for the computer will, in many cases, determine the minimum acceptable characteristics of the device. The I/O (input/output) devices you're most likely to encounter on personal systems are keyboards (for input) and video displays and printers (for output). Let's look at each variety in turn.

Keyboards

The most common way of entering data into a personal computer system is through a keyboard. Although in general it resembles a typewriter keyboard, there are usually some differences. There may be a separate 10 key numeric keypad to

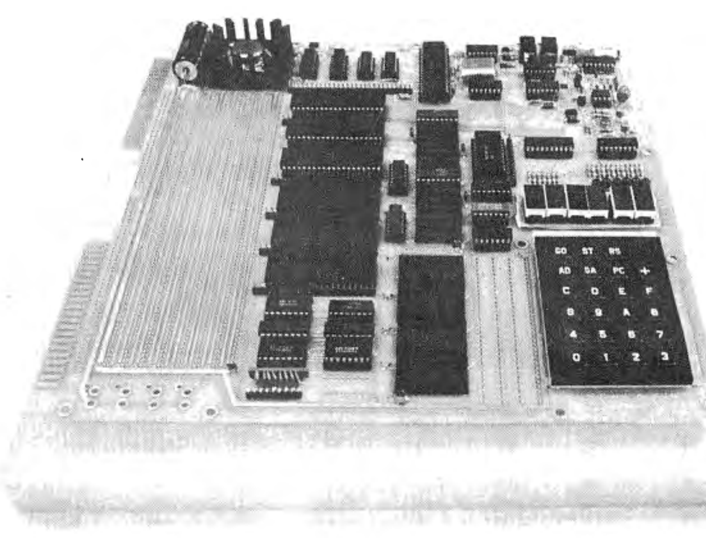


Photo by Elizabeth Hughes

7 The SwTPC 6800, a mother board computer.

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one side as well as additional keys which reflect the fact that it is for use with a computer. A *control* key is used much like a shift key, but instead of causing capital letters to be sent, it produces specially designated *control characters.* For example, control held down when C is depressed (called control C) is often used to "get the computer's attention," that is, stop whatever it is currently doing and prepare it to receive instructions. If a keyboard is connected to a video display, it often has keys intended to control the position of the *cursor,* the mark displayed on the screen to show where the next character will be printed. Arrows are usually used to label the keys which move the cursor up, down, right, and left, while other keys are usually labeled with their functions. Thus, *home* positions the cursor in the upper lefthand corner of the screen — at the first position in the first line.

Keyboards are available in a number of configurations. They may form part of a printer (for example: a Diablo Hytype, photo 8; or a teletypewriter, photo 9) or of a video terminal (photo 10) or they may be purchased separately. However you acquire your keyboard, though, there are two essential considerations. Most important, is it comfortable? and, nearly as vital, how easily will it interface to your computer? Both these questions are critical, since a keyboard that can't be hooked up to your system is worse than no keyboard at all, while an uncomfortable keyboard will be an actual deterrent to using your computer. It is a great mistake to assume that you can get used to an awkward keyboard. A difficult to use, unreliable keyboard, which sometimes outputs a character twice and sometimes not at all, can prevent you from using and enjoying your system. Sticking keys are as great a problem. So this is one purchase that absolutely requires "hands on" shopping. Don't trust the advertisements or take anyone's word about it. Try the keyboard yourself for comfort and

9

Several styles of keyboards combined with output devices. A keyboard may form part of a printer, for example, the Diablo Hytype at 8, or the teletypewriter at 9. The ADDS video terminal at 10 is another example of a keyboard which is combined with an output device.

8

10

Play it safe by trying the keyboard for a long enough time to be sure you will be comfortable with it. Since it will probably be your primary method of talking to the computer, it's worth the trouble.

convenience. Even without severe key action problems, the slightly different key layouts favored by different manufacturers can make using a keyboard harder or easier. Play it safe by trying the keyboard for a long enough time to be sure you will be comfortable with it. Since it will probably be your primary method of talking to the computer, it's worth the trouble.

The second consideration, ease of interfacing, applies to *all* peripheral devices. If you know something about digital design and have the skills required, it is often possible to design an interface between your computer and the device in question, if you have enough information about the two devices to be joined. Mother board computers usually have available serial and parallel interface cards which can simplify the process. But in some cases, creating a truly satisfactory interface is sufficiently difficult, time consuming, and expensive (in cost of parts for the circuit) that you'd be better off just choosing a version of the device which is easier to interface. If you don't want to design and execute interfaces for every device you add to your system, it's better to choose peripheral devices — and your computer — with this problem in mind. Some interfacing involves nothing more than buying a box or a printed circuit card to connect between the device and the computer and plugging them all together. Perhaps this is the sort of interface you would prefer. If so, you must pick your peripheral devices with care, but you can find ways to avoid the complexities of do-it-yourself interfacing.

Sooner or later you will probably have a keyboard of some sort as part of your system. The convenience of being able to simply type in anything you want to enter is so great as to be irresistible. Take care, then, in choosing so you won't want to replace it later.

Printers

Whether you need or want a printer and what sort to get will depend to a great extent on your primary application. If you're doing assembly language programming, a printer will be highly desirable, since it's virtually impossible to debug an involved assembly language program without a printed listing. If you're using your computer for word processing, or text editing, a printer is again essential, but in this application you will want one that produces letter quality output. A letter quality printer is considerably more expensive than a printer which doesn't have to meet such demanding standards, but in some applications there is simply no substitute. Another application which requires a certain kind of printer is outputting forms, mailing labels, invoices, and the like. For any application where the print must fall in closely specified areas of the paper, a tractor feed printer is required. Without this method of keeping the paper properly aligned and advancing it at the correct rate, the printed material will slowly move out of alignment, eventually missing the position in which it was supposed to be printed by a considerable margin.

There is a wide range of printers on the market, and if your applications require printed output you will find a wide selection to choose from. If you don't need to have your output on standard paper, there are numerous printers calling for special paper and using diverse processes (thermal, electrostatic, electrographic, etc) to produce perfectly readable output. If you don't need the 80 character or 132 character print line necessitated by word processing and many small business applications, you may find that one of the 20 to 40 character printers available makes a good, inexpensive solution. If you don't need high print speed, you may find that an inexpensive rebuilt teletypewriter is what you want. The possibilities are many; once you decide you need a hard copy output device, you can easily narrow the field by answering a few questions about your needs.

The first question, as always, is: how easily can the device be interfaced to your system? You can immediately rule out any printer that will involve more trouble and expense to interface than you are willing to permit. Second, is the use of ordinary paper important in your output? If so, you can eliminate all printers requiring special paper. If not, a printer that uses special paper may offer a comparatively inexpensive alternative if you won't be doing so much printing that the higher cost of the special paper (twice to four times) grows excessive. Third, do you need upper and lower case? A high percentage of printers print only upper case, so your selection is broader if you can do without lower case. Correspondingly, if you need both upper and lower case, the number of possibilities will be automatically limited. Fourth, what is the smallest number of characters per line you can use? If you must have at least an 80 character line, you can forget about the 20 character, etc, printers; and if you need at least 132 characters per line, any printer that prints no more than an 80 character line is eliminated. Fifth, do you need letter quality

output or plotting capability? Either one of these needs will drastically reduce the number of printers to be considered, and, if you need both, I know of only a handful of printers that can meet your needs. Sixth, do you need the precise positioning that tractor feed can provide? This option increases the cost but is the only way to satisfactorily handle forms, mailing labels, and the like. Seventh, must your printer be able to make carbon copies? If so, all nonimpact printers can be ruled out unless you're willing to print as many originals as the carbons you would normally make. Eighth, what about speed? Are you going to be doing so much printing that you must have high speed? Or can you get by with a slower — and often less expensive — printer?

Answers to these questions will only rarely narrow the field to a single printer, but understanding what you need in an organized form will prevent you from overlooking some necessary characteristic. In some cases, your answers will permit you to form a complete enough description of your needs so that you will be able to reduce the field quickly to three or four options. When you actually start looking for a printer, there are two things you must determine by seeing it in operation. Most important is what the printing actually looks like. Published photographs are inadequate for determining the clarity of the print and can be very misleading. Some print comes across smudgy in a photo but is perfectly clear "in person," and vice versa. The other consideration is noise. If your printer is very noisy, your neighbors may complain even if it doesn't bother you. Look at and listen to the printer before buying, especially if you can see one that isn't brand new — yours won't be new for very long. Then you'll be in a much better position to make a choice you can live with.

Look at and listen to the printer before buying, especially if you can see one that isn't brand new — yours won't be new for long.

Video Displays

Until recently, almost all the work currently done by video displays was done by printers. Now, however, video monitors have become such a common part of computing that few people can imagine a computer without one. These days, someone referring to a computer terminal usually means a video terminal (incorporating a video output device) instead of a printer terminal (utilizing

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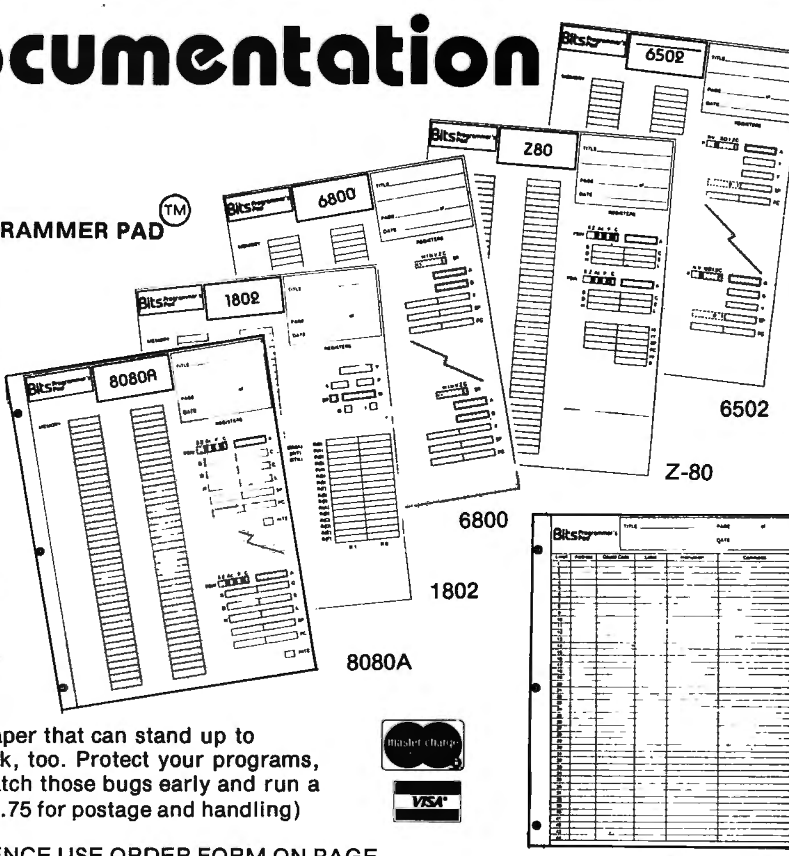

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. . . no matter how nice the display is, if the keyboard is unsatisfactory, you'll rue the day you made the purchase.

printed output). Let's find out what options are available in video displays.

There are several approaches to displaying computer output. Lights on a computer's front panel were the original displays, and digital readouts capable of displaying numbers or letters were also used. I'm assuming that you want something more than that, permitting the display of many lines of characters. For this purpose, there is essentially only one possibility: a video display (like your television set). There are other techniques such as plasma displays or large liquid crystal displays, but none of these are sufficiently available to the personal computer user. Video displays are available in a broad range of sizes with an equally wide range of specifications.

One question to ask is, do you *need* a video display? If your interest is computer graphics, certain sorts of games for which a printer is inconvenient, or a wide range of business applications, a video display may be almost essential. Here again, the job you expect your system to perform will influence your choice. While the computer hobbyist may be perfectly satisfied with a monitor that displays only 32 characters per line and only eight lines; someone doing word processing, text editing, or most business applications will need at least 24 lines of at least 80 characters each. Others engaged in computer graphics will need a monitor with graphics capability and possibly color, and so will the games enthusiast. People with either of these two interests will also benefit from having the ability to control the cursor's position through the computer. Graphics or games usually don't demand the ability to display both upper and lower case characters, but anyone doing text editing will find this capability essential.

Still another capability is usually necessary for business applications, which are likely to require the ability to display forms (such as invoices), fill in the blanks, and then store that information in the computer for later output to a printer (without storing the entire form each time). This sort of use demands something called *screen read* capability, which enables the computer to read and store the filled in data on command.

While you may be able to get along nicely without a video display for many applications, any use which requires video will carry with it certain fundamental requirements which will influence your selection. If you need 24 or more lines of 80 characters apiece, you will probably *not* choose a 4 inch diagonal display screen, for instance.

There are two basic approaches to adding a video display to your system. One is to buy a self-contained unit, with or without keyboard, intended to interface to the computer through one of its serial or parallel I/O ports. This approach has much to recommend it, since a large selection of self-contained units is available, offering almost every imaginable combination of capabilities. Further, these units interface directly to the computer, limiting your need to get involved with the computer's hardware.

A second approach is also possible. Some computer systems can accommodate a video controller printed circuit card that permits you to use either your television screen or a separate monitor for output. Although 32 characters per line (or occasionally 64) is the maximum you can expect from a television screen, many uses call for no more than this. Most users will find a self-contained video terminal to suit their needs, but the use of a video controller card can provide a less expensive alternative by allowing the user to create a satisfactory terminal — and one which may have good graphics capability — using an ordinary television set along with a secondhand or surplus keyboard.

As with printers, buying a video display is a distinctly "hands on" business. Photographs of display quality are even more misleading than photographs of print quality. Seemingly trivial differences in type style, contrast, and clarity can make one unit utterly unusable and another perfectly satisfactory. If you're buying a terminal, don't forget to test the keyboard as thoroughly as you would if you were buying it separately. Since it's attached to your video display, you'll probably use it a great deal, and no matter how nice the display is, if the keyboard is unsatisfactory, you'll rue the day you made the purchase.

Video displays require as much care and comparison shopping as any other part of your system. Take your time. Think beyond your current use to interesting projects which you have postponed. In a year you may return to those projects only to find that they've been made more difficult by a thoughtless choice of equipment.

There are other sorts of input and output devices, such as punched card readers and punches, paper tape reader/punches, and so on. But they are sufficiently uncommon in personal computer systems that no effort is made to discuss them here. A different phase of input and output, however, is represented by external storage media, which can be used to store data and programs during periods when the computer is powered down,

and from which the computer can retrieve stored data as needed.

External Storage Media

There are several benefits to be gained from including external storage media in your system, even though some applications do not absolutely require their presence. The most obvious is convenience. Your computer's programmable memory is volatile, which means that you must either keep the computer running all the time or reenter programs each time you start it up. Even a brief power failure can cause the loss of everything stored in programmable memory. There are nonvolatile forms of programmable memory, but they are generally quite expensive, take up much more space and require much more power than the volatile semiconductor memory usually found in personal computer systems. They are also largely unavailable for microcomputers. The only nonvolatile memory readily available for home systems is read only memory — the computer can read from it but cannot program it. Therefore, nonvolatile storage for programs and data is extremely helpful if you propose to run any program more than once.

Even if the available programmable memory were nonvolatile, there would be uses for external storage media. Sometimes you want to process more data than your computer can store in its programmable memory. Few personal computer systems can address more than 64 K bytes of memory. Although this is usually more than enough for long programs, it's not enough to hold, for example, a mailing list containing 50,000 names and addresses or an inventory containing 100,000 items. Besides, you don't *need* to have all 50,000 names and addresses stored in the computer at once if there is another, computer-accessible, place to store them. All you need is to be able to give the computer some names to work on and when they have been printed out on mailing labels or whatever, give it some more. The main thing you want to avoid is having to type in all 50,000 names and addresses each time you want to print a set of mailing labels.

Similarly, if you want to run a program written in, say, BASIC, you don't want to have to enter by hand the entire program that lets you run BASIC programs, then enter the program you want to run, before being able to run it. This is what external storage media is all about. External storage lets you keep programs and data you want to reuse in a computer-accessible form so that you can enter them quickly and easily whenever you want them. If your application involves keeping records — of inventories, mailing lists, or whatever — you'll

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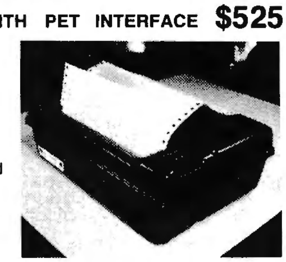

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The alternative to audio tape is the magnetic floppy disk, which offers both increased data storage and random access to the stored data.

find some external storage device is essential. And when you have chosen your device, bear in mind the need to keep a copy of all such information. To a hobbyist, the loss of information is little more than annoying, but to a business the loss of records can be disastrous.

Let's look at the most readily available external storage media.

Audio Cassette

The most popular form of external storage is the audio cassette. With a comparatively inexpensive cassette interface, a low cost audio cassette recorder can be connected to your computer in such a way that you can load programs and data onto standard audio cassettes and reload them into the computer later. Good quality cassette tape is required, but any of the reliable brands on the market will do. This is the simplest and least expensive way to add external data storage to your system.

The data is recorded in the same way music is recorded on cassettes and no unusual precautions are required to protect the cassettes once recorded. Keeping them in their cases is usually quite adequate. The speed with which you can store and load programs depends primarily on the cassette interface you choose. This speed, or data transfer rate, is measured in bits per second. The rate of data transfer depends on how densely the data is packed onto the tape, and the cassette interface must be able to accept data from the cassette and pass it on to the computer at the rate at which the cassette was recorded, or only gibberish will result.

Most of the software available for personal computer systems can be purchased in the form of cassette tapes containing the programs. This makes the ability to accept cassette input very useful. But there are disadvantages to relying on cassette storage alone. For example, since the quality of the tape limits the density with which data can be stored, there are fairly harsh limits to the amount one can store on a single cassette. A more important drawback is that you can access a piece of data on the tape only by going through all the preceding data until you reach it. Then, if the next piece of data is among those you've already passed while searching for the first piece, you must go through the entire tape and start at the beginning again in order to find it. Needless to say, this is time consuming. It is most desirable, then, to have random access external storage, not the sequential access storage a tape offers. While many hobbyists can get by without the benefits of random access external storage, there are many applications which require it.

Magnetic Floppy Disk

The alternative to audio tape is the magnetic floppy disk, which offers both increased data storage and random access to the stored data. Like a tape, the disk is coated with fine particles of a substance which can be magnetized, and data is stored on the disk by magnetizing these particles to represents 0s and 1s. The data are read from the disk by read heads similar to those that read magnetic tape, but which can be moved above the spinning disk to locate any item of data that is required. If someone is handling customer orders, checking them against inventory, this ability to go directly to the data required is a real timesaver. In fact, in almost any inventory application it is practically essential to be able to pick a particular item of data from the rest with the speed and reliability devices like this offer. In many other applications as well, the random access and high data storage volumes of disks are worth the additional cost.

Floppy disks are better and more convenient than cassette tape in every application and are a good choice if the budget allows, but cost is the great deterrent. The fundamental cost of a floppy disk drive is about five times as great as the cost of setting up to use tape and the storage media (the disks themselves) are more expensive. To top things off, a single floppy disk drive is adequate for very few applications. Cassettes are sufficiently inexpensive that you rarely fill them with data completely, with the result that you can usually store the entire contents of a cassette tape in your computer's memory if you need to copy it onto a separate tape but lack a second recorder. The expense of a floppy disk, however, insures that you will fill it as completely as possible, making it almost impossible, without vast computer memory, to make a copy of its data with only a single drive. In a pinch, a cassette recorder plus a single floppy disk drive can make a passable combination, but if your application calls for disks, it is preferable, where possible, to obtain two.

Whichever route you take, external storage will be a highly desirable adjunct to your system. When you go to purchase either cassette recorders or floppy disk drives, the main things to look for are reliability (to reduce the frequency of breakdowns) and local repair service (to keep you from losing too much time to repairs). As always, remember to be sure the device can be readily interfaced to your

system. You can never assume compatibility between computing equipment. If it doesn't say so in so many words, it probably isn't compatible. Compare the available systems for the cost of the media, the amount of data that can be stored, and ease of use. With these factors in mind, selecting the one most suitable to your situation should be easy.

Software

The side of a computer system that buyers most frequently overlook is the software available for it, yet proper software is more important to your satisfaction with the system than almost any other single item. Therefore, software is the next topic to consider.

Without a program, a computer can do nothing — and with an unsatisfactory program, a computer can be a hindrance rather than a help. For this reason, one of the most important parts of your computer system is the software. Indeed, software is such a vital part of the system that it can influence your decisions about hardware purchases. If the programming you need is not available for a system you're considering buying, and you're not in a position to provide your own programs to suit your applications, it may be wiser to look for another system which offers the software you need. Let's see what's involved in this side of your system.

Programming languages are the tools which let us give computers commands. The greatest speed in running a program is usually attained if the program is written in the computer's machine or assembly language, but few applications apart from process control can benefit from this speed, since the rate at which one gets the computer's results is most often dependent on the speed with which the (inevitably slower) output device, a printer or video screen, can output the information. (This same consideration also tends to make comparisons of processor speed irrelevant.) If your main use for computers is process control or some analogous application, you probably should be willing to learn the computer's machine language or, if available, assembly language. If you are interested in another type of application or are unwilling to learn assembly language, your first concern will be to determine what *higher level* languages are available.

A higher level language, while running somewhat more slowly, is easier for humans to use. Instead of needing to understand what goes on inside the computer to write out the several steps involved in a simple addition, for instance, one can evoke the addition process by using a straightforward statement like LET A = B + C. A program already in the computer does the work of putting this into a form the computer can use. The major benefit gained from using higher level languages is that a program in, say, FORTRAN can be run with few or no changes on any computer which has been programmed to handle FORTRAN, while an assembly language or machine language program can only rarely be run on anything but a computer of the same model as that for which it was written. The immediate benefits for users are that higher level languages are often easier to learn and that a program written for one machine should be usable with minimal changes on any other computer which is prepared to accept the language.

The most common higher level language for personal computer systems is BASIC, originally developed as a language for teaching programming. Almost every personal computer system on the market has at least one version of BASIC available, and multiple versions are available for several systems. BASIC is easy to learn, and there is a wealth of published programs in BASIC dealing with a great diversity of applications which you might be able to adapt for use on your own system.

But suppose you already know a computer language and it isn't BASIC? Do you have to learn BASIC? No. Versions of a number of other languages have been written for personal computers. But there's a catch. Only BASIC is almost universally available. Thus, if you want to use some other higher level language, you must pick your system with care or be prepared to write the program that lets your computer use that language — a prospect few people are equipped to face.

If you don't intend to do *any* of your own programming (and don't have a captive programmer in the wings waiting to save the day), your selection of a computer will be even more heavily dependent upon available programming. In this case, you must not only choose a machine with a good version of a higher level language available, but also study the magazines and the advertisements from software houses in search of the programs you need, written in a form your computer will accept. The catch here is twofold: if the program is in the BASIC offered for another machine, you will almost certainly have to make a few changes to get it to run smoothly on your system; and a program that looks like what you need *isn't* necessarily what you need. To the person who is familiar with programming, the delays these problems can cause in getting the system running can be unimportant. But, if you're using the computer in business, delays can be deadly.

Until recently it has been practically impossible for someone to enter personal computing without planning to learn programming. This is changing as software firms expand their offerings. It will always be wise, though, to compare available software

when purchasing a system, and if you can bring yourself to learn BASIC (or importune a friend who can program), it will strengthen your position considerably.

This brings us to another subject worthy of brief mention: how can you learn about computing?

Learning the Essentials

If you're entering personal computing with little or no background, you're going to need some help getting started. There are several ways you can get this help. Magazines regularly run articles to help provide this information in a clear and palatable form. They are the first option, since buying an issue of a magazine is a small investment that can bring big returns in information.

A more expensive but more thorough possibility is to buy books from your local computer store or by mail order through ads in magazines. For example, dozens of books explain how to program in BASIC. Hardware and software are equally well covered. If possible, look through a copy of the book you're considering before you buy it. If you find that the author's style annoys you, or if it doesn't seem clear to you, look for another. The reason many books are published on the same subject is that both readers and writers have different viewpoints — the book you decide against will probably be chosen by someone who would reject the one you buy.

The most expensive alternative for learning about computing is to enroll in a class offered by a local school. The time and expense involved, coupled with the inability to judge in advance if the course will teach what *you* need to learn, make this an option few will choose; but you may find a lot of benefits if you decide to try it.

When you're no longer a complete beginner, try the local computer club if your town has one. You'll find them a fruitful source of fascinating conversations and explanations.

The more you can learn about computing, the more fun and profit you will get from owning your own system. Never be afraid to ask questions or dig up references. Your own personal computer system itself will be a first rate instructor, and you'll get more comfortable with computers each time you use it.

Cost

As you have seen earlier, what you need in the way of computing equipment will depend on what you propose to do with it. For this reason, it is impossible to name a flat sum and say, "You can get what you need for so much."

What you can do is to figure out the general price range of the equipment you'll need. To simplify this process, I have prepared three tables. Table 1 shows the system requirements for some of the most common applications. With luck, you'll find something close to your intended application among them. This gives you a place to start. The table doesn't include prices because the ways of meeting any particular need are various and the price ranges involved vary so widely that a reasonable figure would be almost impossible to establish in most cases.

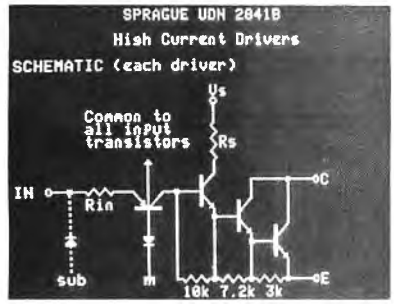
Table 2 shows examples of price ranges. I have listed the components which might be used to make up a personal computer system and the usual price ranges for each of the most common ways of providing those components. Where an item might be satisfactorily available used, through a surplus house, I have included a used price range — but since the availability of surplus equipment changes radically from month to month, it is unwise to rely on finding an item surplus, in usable condition and within the price range. Also note that although I generally list an upper limit on new prices, there is no actual limit in most cases. The upper end prices shown are the most you are likely to have to spend — but your particular application might require a product which costs many times the price of its more ordinary parallels.

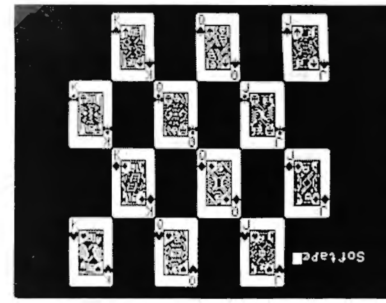
Given these two tables, you can get a rough idea of your probable expense. Take the application closest to your own and list the equipment it requires. Then fill in price ranges beside the equipment, following table 2. Sum the result and you'll have the general price range. From this you can deduct the cost of anything you don't need, due to special circumstances. For example, if you have a suitable terminal already, deduct the cost of buying one.

Table 3 is designed to help you figure costs more closely. It provides a worksheet on which to figure your personal needs. There's a list of equipment and software and a column to write in prices. You can start filling it in by selecting the application closest to yours from table 1, but now you need only mark those parts of the system that definitely apply to you. Leave out, or replace with a less expensive option, items where you can settle for less, and add on any items you might need which are not included for the application in its pure form. Then, fill in price ranges from table 2 and total them.

Don't let the total frighten you. In many cases, this cost can be spread out over a long period of time. If you're building your system from kits, for example, there is no need to buy the second kit until the first is built, by which time you may be better able to afford it. Similarly, if you buy a mother board system, you can frequently forestall the cost of additional memory or I/O (input/out-

APPLE HI-RES GRAPHICS: The Screen Machine by Softape





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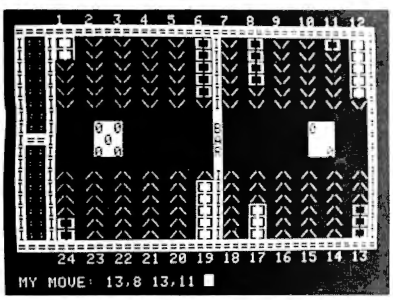

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Table 1: Common applications and the computer equipment they require.

	Computer	Input	Video
Games	At least 16 K bytes of programmable memory	Keyboard	Preferable, 64 characters per line minimum, color desirable
Inventory	At least 32 K bytes of programmable memory	Keyboard, preferably with numeric keypad	Usually desirable, 24 lines, 80 characters per line
Text Editing and Word Processing	At least 32 K bytes of programmable memory	Keyboard, preferably upper and lower case	Desirable, at least 24 lines, 80 characters per line
Process Control	At least 8 K bytes of programmable memory Wide range of input/output (I/O) ports Single board computer may suffice	Transducers, switches, analog to digital converters, etc Keyboard generally desirable	
Software Development	At least 16 K bytes of programmable memory	Keyboard	Convenient, but not essential
Accounting	At least 32 K bytes of programmable memory	Keyboard, preferably with numeric keypad	Desirable
Scientific, Cartographic and Architectural Calculation	At least 32 K bytes of programmable memory	Keyboard Digitizer for converting analog information to digital data	Graphic capability desirable
Graphics	At least 64 K bytes of programmable memory	Keyboard Light pen often desirable	Color and high resolution display
General Purpose	At least 16 K bytes of programmable memory	Keyboard	64 characters per line minimum

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Hard Copy	External Storage	Software	
	Cassette is adequate	A good version of a high level language, usually BASIC	**Games**
Printer, 80 to 132 characters per line	Two 10 M byte disk drives	Good high level language Inventory control package if person using system is not a programmer COBOL or other business language preferable	**Inventory**
Letter quality printer, 80 to 132 characters per line	At least one disk drive and one cassette	Text editor for manipulating data, justification of text, centering titles, etc	**Text Editing and Word Processing**
Printer for program listings, readable quality, 20 to 40 characters per line	Cassette usually adequate	Assembler/editor preferable	**Process Control**
Printer for program listings, readable quality	Cassette sufficient Cassette and single floppy disk drive preferable Dual floppy disk drive best	Usually an assembler and a higher level language Debugger program desirable	**Software Development**
Impact printer to make carbons, with tractor feed for printing forms	Two disk drives	Accounting software package if the person using system is not a programmer Business language, like COBOL desirable If high level language is used, make sure calculations can be performed to enough decimal places	**Accounting**
Printer Plotter often desirable	One disk drive and one cassette may suffice	Good version of a higher level language, preferably Pascal or FORTRAN	**Scientific, Cartographic and Architectural Calculation**
Printer and plotter frequently considered essential	One disk drive and one cassette may suffice	Assembler, editor and a high level language, with graphics options if possible	**Graphics**
Printer convenient, but not essential	Cassette is adequate	BASIC, editor and assembler	**General Purpose**

put) ports until you actually need them. These and many other tricks can be used to reduce the amount of cash you must spend at any one time.

When you make the decision to go ahead and have selected the equipment you intend to buy, compare prices between local computer stores and direct factory order. Frequently the manufacturer will charge slightly less than a retail dealer does, but this is often offset by late delivery. Delivery lead times, even from large minicomputer and mainframe suppliers, can easily stretch to 90 or 120 days if the demand is high or if a crucial part is unavailable. If you need the computer device immediately, the only way to assure getting it promptly is to find a dealer with one in stock and, if need be, pay the higher price.

Computers

Single board	\$100 to \$300 kit, \$250 to \$900 assembled
Mother board	\$400 to \$2000 kit, \$500 to \$2100 assembled
All-in-one	\$600 to \$9000 assembled

(includes keyboard, cassette interface, BASIC, and elementary operating system; may include video display and additional capabilities)

Input and Output Devices

Keyboard (when purchased separately from terminal)	\$50 to \$200 kit, \$100 to \$300 assembled
Numeric keypad	\$20 to \$50
Printer (when purchased separately from terminal)	\$400 to \$1200 for 20 to 40 characters per line \$2000 to \$3000 for letter quality or impact printer
Video monitor (when purchased separately from terminal)	\$125 to \$300 used, \$175 to \$500 new
Plotter	\$500 to \$1500 and up
Digitizer	\$500 and up
Video terminal	
Fewer than 80 characters per line	\$40 to \$400 kit, \$500 to \$2000 assembled
80 characters per line and up	\$550 to \$1200 kit, \$750 to \$5000 assembled

Color capability usually adds \$500 to \$1500 or more to the cost.

Light pen usually adds about \$100 to the cost.

Printer terminal	
80 characters per line and up	\$300 to \$2000 used, \$1000 to \$4000 and up new
Letter quality or impact printer	\$600 to \$2000 used, \$2000 to \$4500 and up new

Plotting capability can add \$500 to \$1500 or more to the price.

Tractor feed usually adds about \$100 to the price.

External Storage Devices

Cassette interface	\$25 to \$125 kit, \$60 to \$200 assembled
Single floppy disk drive	\$600 to \$1000 assembled
Dual floppy disk drive	\$1000 to \$3600 kit, \$1500 to \$4000 assembled
10 M byte disk drive	\$6000 to \$8000 per drive

Additional Programmable Memory

\$200 to \$350 per 8 K bytes	(heavily dependent on the type of computer and the amount of additional programmable memory purchased at one time)

Software

Editor \$30 to \$500	Assembler \$10 to \$300
BASIC \$10 to \$900	Operating system \$100 to \$1800

Inventory or accounting package \$100 to \$1000

Some companies include fundamental software with their equipment. Note also that professional software for *mini*computers can cost up to ten times the prices shown above.

Table 2: Price ranges for computing equipment. Because the prices and offerings on the market are constantly changing, these price ranges are to be taken as "ball park estimates" only. Where it is justified by a wide selection or a substantial price difference, I have included separate price ranges for used equipment and for kits.

		Price
Computer	____ Single board	________
	____ Mother board	________
	____ All-in-one	________
Input and Output Devices	____ Separate keyboard	________
	____ Separate printer	________
	____ Separate monitor	________
	____ Video terminal (not 80 char)	________
	____ Video terminal (80 char +)	________
	____ Color capability	________
	____ Printer terminal	________
	____ Letter quality terminal	________
	____ Plotting capability	________
	____ Tractor feed	________
	____ Separate plotter	________
	____ Digitizer	________
	____ Light pen	________
	____ Numeric keypad	________
External Storage Devices	____ Cassette Interface	________
	____ Single floppy disk drive	________
	____ Dual floppy disk drive	________
	____ 10 M byte disk drive	________
Additional Programmable Memory	____ 8 K	________
	____ 16 K	________
	____ 32 K	________
Standard Software	____ Assembler	________
	____ Editor	________
	____ Operating system	________
	____ BASIC	________
	____ Inventory or accounting package	________
	TOTAL	________

Table 3: A system price worksheet. Put a check by the equipment you need and fill in the prices in the spaces provided. The total should give some idea of the system cost. The resulting figure, although it does not include special software or the external storage media such as floppy disks or cassettes, should provide a general notion of what the best system for your needs would cost. If it looks high, consider that you may be able to begin with a less than optimal system that will meet most of your needs.

Conclusion

Getting started in computing can be one of the best decisions you ever make. It can be fun, profitable, and a source of many pleasures — regardless of what your primary application may be. This article has attempted to provide some warnings and guidelines to help you choose a system that will be adequate to your needs and not easily outgrown. Now it's up to you to define what components compose the best system for *your* purposes. Happy computing! ■

The author would like to acknowledge the generous assistance of the following computer stores in the preparation of this article:

Radio Shack, Buford Hwy, Doraville GA
Radio Shack, Lenox Sq, Atlanta GA
Computer Mart, Buford Hwy, Doraville GA
Compushop, Roswell Rd, Atlanta GA
Olson Electronics, N Decatur Rd, Decatur GA

Glossary

Address: an identifying number (often hexadecimal or decimal) used to describe a location in computer memory.

Algorithm: an orderly procedure (akin to a recipe) for obtaining a particular result or solving a problem. Algorithms are often expressed in mathematical terms.

Assembler Language: synonym for assembly language.

Assembly Language: a form of computer language that uses mnemonic names to stand for one or more machine language instructions. The latter are the most basic instructions in the computer, and assembly language is a "shorthand" method for avoiding the tedious use of long strings of ones and zeros found in machine language. The advantage of assembly language over high level languages such as BASIC is its speed, although high level languages are generally easier to use than assembly language.

Array: in computer usage, the setting aside of a section of memory to hold a group of related data values. More specifically, arrays are indicated in the BASIC language by subscripted variables, such as A(X), where X is the subscript.

Base: the number on which a given numbering system is built. For example, the decimal number system is a "base 10" system—that is, it has ten unique symbols (digits), and each place in a number represents a power of the base number (10 in this case). The binary number system is base 2.

BASIC: a type of high level language popular among personal computer users.

Break: a key which is used to interrupt a computation and return the computer to a user-input mode.

Binary: a type of number system based on the number 2, compared with the decimal system, which is based on the number 10. The binary system uses only the digits 0 and 1; and each place in a number represents a power of 2. For example, 101 in binary is the same as 5 in decimal.

Byte: the basic unit of information in the computer. A byte consists of binary bits, usually eight in microcomputer terms.

Code: synonym for a computer program; ie: a programmer generates *code.*

Debug: to search for and correct mistakes in a computer program. The term is also used in reference to fixing electronic circuitry.

Direct Memory Access: a fast and convenient method of data transfer, enabling a peripheral device to transfer data directly from the memory circuits, without requiring action from the main processor (except to start the transfer, if needed). It is used frequently in video display systems and in disk systems and is often abbreviated as DMA (see also programmed data transfer).

Disassembler: a program which takes machine language code and generates the assembler language code from which the machine language was produced (see also assembly language).

Dynamic Memory: a type of programmable memory. Data is held in the form of electrical charges on tiny capacitors inside integrated circuits. Dynamic memory requires "refresh" operations to prevent the data from being lost. It is usually cheaper and often faster than static memory.

Floating Point BASIC: a type of BASIC language which allows the use of decimal numbers. The name comes from the fact that the decimal point "floats" to a new position in a number, as required, following a calculation.

Instruction Set: all of the possible op codes a microcomputer can execute (see op code).

Integer BASIC: a type of BASIC which can process whole numbers only; no decimal numbers are allowed. See BASIC and floating point BASIC.

Interrupt: the stopping of a process so that it can be resumed at a later time.

Label: a name comprised of letters, numbers or symbols used to identify a statement or instruction in a program.

Memory: a place in a computer where data and programs can be stored.

Modem: short for modulator/demodulator. A device used to send data over communication lines, such as telephone lines. The modulator section encodes the information for transmission to another modem. Incoming information is decoded by the demodulator section.

Op Code: a binary code used to identify a particular function which can be carried out by the computer; short for operation code. Also called machine code.

Operand: a number which is operated on in a computer program.

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PEEK: a BASIC instruction that allows the programmer to look at (peek at) any location in programmable memory. This instruction is often used to scan the memory locations which hold the information displayed on the video monitor in order to determine what is being displayed.

Peripheral: a device external to the computer, but which interacts with it, such as a printer, floppy disk unit, cassette recorder, etc.

POKE: a BASIC instruction used to place a value (poke) into any location in programmable memory. This instruction is often used in conjunction with the PEEK instruction to display graphics on a video display.

Process Control: the use of a computer (or other electrical or mechanical devices) to manipulate the parameters of a process. An example of process control is the use of a microcomputer to control your home heating and air conditioning.

Programmable Memory: content changeable memory, as opposed to read only memory (the contents of which are fixed during manufacture). Programmable memory is where most programs and data are stored. It is sometimes called random access memory, or RAM, but this is a slight misnomer.

Programmed Data Transfer: the most common method of data transfer in microcomputers. Each byte of data passes from the memory circuits, through the main processor, and out to the peripheral device in the case of output; and in the opposite direction in the case of input. Programmed data transfer requires the constant attention of the computer program for the transfer to continue, hence its name (see also direct memory access).

Read Only Memory: a special type of computer memory. It is permanently programmed with one group of frequently used instructions. Read only memory does not lose its program when the power is turned off, but the program cannot be changed by the user. In many personal computers, the BASIC language interpreter and operating system are contained in read only memory. This term is sometimes seen abbreviated as ROM.

Register: a place in a computer where numbers can be temporarily stored and operated on.

RS-232 Interface: a data communications industry standard for the serial transmission of data to a peripheral device, such as a printer, a video monitor, a plotter etc. Most personal computers have an RS-232 interface port.

Scrolling: the vertical movement of lines on a video display, so that the top line disappears and a new line is displayed at the bottom of the screen.

Static Memory: a type of programmable memory. Data is held by changing the position of an electronic "switch," a transistor flip-flop, contained in integrated circuits. It does not require refresh operations, as does dynamic memory.

String, Character: a sequence of characters (letters, numbers, and symbols) used in high level languages such as BASIC.

Switching Power Supply: an efficient type of power supply that produces power in a compact package.

Trace Command: a command in some high level languages (such as some BASICs) which causes the computer to list the exact order of program steps executed while running a program. The trace command is useful for debugging programs.

If you would like further information about the terms described here, or about other computer terms we might have missed, the following two books are particularly useful:

Burton, Philip E, *A Dictionary of Microprogramming,* Garland Publishing Inc, New York, 1976.

Weik, Martin H, *Standard Dictionary of Computers and Information Processing Second Edition,* Hayden Book Company Inc, Rochelle Park NJ, 1977. ■

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No pretension here. An alcove off of the display area serves as "executive offices" for Stan and Dede Veit of the Computer Mart.

We can be very friendly.

Although that phrase has been appropriated by an oil company as an advertising slogan, it could, with great justification, be applied to Stan and Dede Veit's Computer Mart in New York City.

The Veits, along with about a dozen actual relatives and "adopted" employees, run a computer retail establishment that is typical of many customer-oriented retailers now dotting the country in this fledgling industry.

As one enters the Computer Mart, at 118 Madison Av, the initial impression is of a substantial variety of wares, friendly, knowledgeable, and nonpushy employees in adequate numbers to get involved with the customers, and a homey, "ma and pa" store atmosphere that somehow blends pleasantly with the state-of-the-art technology represented in the products displayed.

The Wares

As is undoubtedly the case with any but the newest computer retailer, the inventory of products handled by the Computer Mart has undergone drastic changes over the lifetime of the store. Indeed, as one of the ancient establishments in the industry (incorporated December 1975; retail operation begun February 1976), the Computer Mart's product line has probably undergone greater change than that of many other retailers.

Today, the Computer Mart carries as wide a variety of hardware, software, publications and miscellaneous electronic gear as is

On any given day, several computers are on display and active, conveniently arranged for easy viewing and use by customers.

necessary to properly serve the broad spectrum of present customers which extends from schools and other institutions to small businessmen to true neophytes (who represent approximately 40% of the customers walking through the front door). Focusing on hardware as an example, the Computer Mart offers a variety of the best known and largest selling personal computers most likely to be purchased by the personal computer hobbyist. At the other end of the scale are multiple terminal, time sharing business systems, ranging in price from $8000 up to $40,000.

On any given day, several computers are on display and active, conveniently arranged for easy viewing and use by customers. For example, when onComputing visited the Computer Mart, there were six small systems up and running in the store's display area. Of these, one was a multiple terminal business system in which four video terminals were displaying four separate programs being run on a single central processing unit. The other five systems were smaller consumer and hobbyist oriented systems running some of the latest software, including sophisticated computer games. Although the arrangement of the displays was casual and comfortable, it was a well-thought-out casualness and comfortableness. The displays, along with the friendly enthusiasm of the personnel, drew the interest of the computer neophyte from our staff who visited the store without overwhelming him with a "this is too much to get a handle on" reaction.

The People

In addition to Stan and Dede, the Computer Mart employs about a dozen other full-time people. Because of the size of the business and the nature of the industry, and because it's more fun that way, most people wear several hats.

It is often said that a man who is his own boss works for a tyrant. The computer store proprietor is no exception. Stan Veit has recently cut back to a 6 day per week 12 hour per day schedule. Then there is Dede. She has an independent career working with handicapped children. The mid-afternoon closing hour of the school where she works gives her a chance to unwind — which to Dede means hurrying to the Computer Mart and working until she and Stan leave for home (usually 9 PM or 10 PM).

In addition to the expected tasks common to most retail businesses (sales, office work, procurement, troubleshooting) any successful retail operation must give a very high priority to its service department. Since the Computer Mart is quite successful, it is not surprising to learn that there are four full-time service people. Stan Veit does acknowledge, however, that finding and keeping competent service people is one of the more important and difficult tasks he faces in running a successful computer retailing operation.

In addition to the full-time employees, there are a few part-timers. For example, there is Dede's 73 year old father who helps with various office chores and who may be the oldest active individual in the industry. There is also Stan and Dede's 13 year old niece who does a little of everything (including selling) and who may be one of the youngest.

The Market

In mid 1975 when Stan Veit was between jobs as a technical writer, he read about the introduction of the first commercially available microcomputer and about the establishment of the first computer retail operation on the West Coast. It didn't take him long to jump into the computer retailing pond

During a lull in the store's activity, the staff plays with the operating systems on the display floor.

...Stan observes that the computer is simply a tool, and not a completely passive instrument of entertainment like a television receiver or a hi-fi system.

with both feet. In fact, it was inevitable.

He was fascinated by the new microcomputing industry; he was tired of working for others and wanted to be his own boss; he had the business sense to see the potential of a new industry; and he had a dedicated, understanding, and hardworking partner. . . his wife.

The Computer Mart opened shop in February 1976 in 500 square feet of floor space squeezed into another company's retail store. In the earliest months, it was so difficult to get products that sales of books and magazines supported the operation. Considering the infancy of the market, the Computer Mart had a good selection of products in its earliest months. This "good selection" of products circa early 1976 consisted of two IMSAI microprocessors and one Sphere, some Processor Technology printed circuit boards, and some miscellaneous video monitors. Stan's instinct as to the potential vigor of the industry had been correct, however: he had orders for 17 IMSAIs before he even had one up and running in his store.

In those early days, virtually the only customers were computer hobbyists who were reasonably well versed in computer technology and who were starving for equipment. Part of Stan's success in the industry, however, stems from his sensitivity to changes in the market and the necessary changes in his product lines and professional staff.

Today, the customers range from institutions (eg: schools) to small businesses, to pure neophytes. Almost all of these customer groups, and especially the neophytes, require substantial "educational time" with Computer Mart employees; thus the sixfold increase in employees in about three years.

A brainstorming session with Stan concerning the future of the industry evokes a number of thoughts that parallel those of others in the industry, but that are expressed with a nice turn of phrase. Although there are those who compare the present state of the microcomputer industry with the early stages of audio or the television industry, Stan observes that the computer is simply a tool, and not a completely passive instrument of entertainment like a television receiver or a hi-fi system. A more useful analysis, in Stan's view, is the photographic industry, in which the amateur or professional photographer must interact with his equipment to create the desired results. Although the sophistication of the "tools" may vary over a wide range (from box cameras to sophisticated 35 mm single lens reflex cameras), at all levels the user must enjoy the interaction. As the industry matures, however, the manual and technical dexterity involved in the user/tool interac-

Dede and salesperson, Suzanne Kerr, fill a book display (right) almost as big as the original floor space of the Computer Mart. Dede talks with a customer (below).

It is the kids, the 10 year olds and 12 year olds, who come into the store without knowledge, without fear, but with curiosity and with enthusiasm.

tion may decrease; as with the recent trend toward increasing automation in single lens reflex cameras.

Another observation that Stan returns to as the conversation progresses is that "the industry is in the hands of the kids." It is the kids, the 10 year olds and 12 year olds, who come into the store without knowledge, without fear, but with curiosity and with enthusiasm. They are unawed by *computers*, a term that for many adults conjures up images a la the 1950s of rooms full of imposing equipment in some large bank or research establishment. Children's eyes see simply a hand calculator and a television screen somehow linked together to produce a wonderful device that is limited only by the user's ingenuity. "See the world through children's eyes" may be a good motto for the microcosm of microcomputing.

Like any retailer, Stan works long hours. Spending so much time at the store, he sees patterns beneath the random ebbing and flowing of the customers and the merely curious who enter and leave the store. In terms of the kids who find computers so comfortable, there's the daily influx of teenagers and pre-teenagers in mid-afternoon after school is out. The very young children, who are a delight in their enthusiasm and easy acceptance of technology, always come on Saturday. In large metropolitan areas, Saturday is divorced fathers' day with the kids.

The Rest

The Computer Mart is more than a computer store; it is a center of computer hobbyist and computer enthusiast activities. In addition to a couple of computer users' clubs that take over the store's facilities after hours for meetings, Stan holds after hours classes in which he teaches computer concepts at various levels.

The treatment accorded the uninitiated is friendly, informative, and not condescending. More and more frequently an adult customer will walk through the door and announce, "I don't know anything about computers."

Rather than try to hype such a customer into a purchase, a salesperson will often advise the customer to purchase an inexpensive elementary book on computer concepts and to return to discuss what he has learned. After a number of return visits and extended conversations, the customer may or may not buy equipment. If equipment is purchased, however, both Stan and the customer will be more satisfied with the final result than they would be if there had been a hasty, ill thought out purchase.

When Stan was a young man sweeping floors in a fruit store, he would muse, "Some day I'll be president of my own company."

Recently, while preparing a storage area to receive new stock, he paused, leaned on his broom, and was quite happy to be his own boss. As he told us, a computer retailer must wear many hats. ■

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CIRCLE 65 ON INQUIRY CARD

Checkbook Balancing Program in BASIC

by Stephen E Sunderland

```
10 DIM NUM(101),DATE$(101),ESTAB$(101),AMNT(101)
11 PRINT
12 PRINT "*CHECKBOOK*"
13 PRINT "CAUTION ******* ENTER ALL DATES AS XX/XX"
14 PRINT
15 INPUT "DO YOU WISH A LIST OF CURRENT CHECK DATA (Y OR N)";B$
20 IF B$="Y" THEN GOSUB 1000 ELSE 30
30 INPUT "DO YOU WISH TO DELETE CURRENT CHECK DATA (Y OR N)";B$
40 IF B$="N" GOTO 103
50 IBAL=0
60 NCHKS=0
61 NUM(1)=9999
62 DATE$(1)="99/99"
70 PRINT "ALL CHECKS DELETED AND CURRENT BALANCE SET TO 0.00"
80 INPUT "NEW STARTING BALANCE=";IBAL
90 INPUT "IS NEW BALANCE CORRECT (Y OR N)";B$
100 IF B$="N" GOTO 80
102 GOTO 110
103 PRINT
104 PRINT "INITIAL BALANCE =";IBAL
105 PRINT
110 PRINT
120 PRINT
130 PRINT "TO ENTER CHECK DATA ENTER THE NUMBER OF THE CHECK,
140 PRINT "THE DATE OF THE CHECK,THE ESTABLISHMENT TO WHICH"
150 PRINT "THE CHECK WAS ISSUED,AND THE AMOUNT OF THE CHECK"
160 PRINT
170 PRINT
180 PRINT "TO ENTER A DEPOSIT ENTER A ZERO FOR THE CHECK
190 PRINT "NUMBER,THE DATE ON WHICH THE DEPOSIT WAS MADE,
200 PRINT "DEPOSIT FOR THE ESTABLISHMENT, AND THE AMOUNT"
210 PRINT "OF THE DEPOSIT
220 PRINT
230 INPUT "ENTER CHECK OR DEPOSIT DATA";N,D$,E$,A
231 PRINT
232 IF D$>"12/31" GOTO 236
233 IF LEN(D$)<>5 GOTO 236
234 IF LEN(E$)>30 GOTO 230
235 GOTO 240
236 PRINT "INVALID DATE"
237 GOTO 230
240 INPUT "IS DATA CORRECT (Y OR N)";B$
250 IF B$="N" GOTO 230
251 NCHKS=NCHKS+1
255 IF E$="DEPOSIT" GOTO 2010 ELSE 3010
270 NUM(NCHKS)=N
280 DATE$(NCHKS)=D$
300 AMNT(NCHKS)=A
320 INPUT "HAS ALL CHECK AND DEPOSIT DATA BEEN ENTERED (Y OR N)";B$
330 IF B$="N" GOTO 230
340 GOTO 20
990 REM CHECK LIST SUBROUTINE
1000 PRINT
1010 PRINT " NO    DATE    ESTABLISHMENT             AMOUNT    BALANCE"
1020 PRINT TAB(45);IBAL
1030 CBAL=IBAL
1040 FOR Z=1 TO NCHKS
1050 IF ESTAB$(Z)="**DEPOSIT**" THEN CBAL=CBAL+AMNT(Z) ELSE CBAL=CBAL-AMNT(Z)
1060 PRINT NUM(Z);TAB(5);DATE$(Z);TAB(14);ESTAB$(Z);TAB(36);AMNT(Z);TAB(48);CBAL
1070 NEXT Z
1080 PRINT
1090 RETURN
2000 REM ENTER DEPOSIT INTO TABLE
2010 FOR Z=1 TO NCHKS
2020 IF D$<=DATE$(Z) THEN GOSUB 4010 ELSE 2040
2030 GOTO 320
2040 NEXT Z
2050 GOTO 320
3000 REM ENTER CHECK INTO TABLE
3010 FOR Z=1 TO NCHKS
3020 IF N<NUM(Z) THEN  GOSUB 4010 ELSE 3040
3030 GOTO 320
3040 NEXT Z
3050 GOTO 320
4000 REM MOVE DATA INTO FILES
4010 FOR ZZ=NCHKS TO Z STEP -1
4015 Z1=ZZ+1
4020 NUM(Z1)=NUM(ZZ)
4030 DATE$(Z1)=DATE$(ZZ)
4040 ESTAB$(Z1)=ESTAB$(ZZ)
4050 AMNT(Z1)=AMNT(ZZ)
4060 NEXT ZZ
4070 NUM(Z)=N
4080 DATE$(Z)=D$
4090 IF E$="DEPOSIT" THEN ESTAB$(Z)="**DEPOSIT**" ELSE ESTAB$(Z)=E$
4100 AMNT(Z)=A
4102 REM CALCULATE BALANCE
4104 CBAL =IBAL
4106 FOR ZZ=1 TO Z
4108 IF ESTAB$(ZZ)="**DEPOSIT**" THEN CBAL=CBAL+AMNT(ZZ) ELSE CBAL=CBAL-AMNT(ZZ)
4110 NEXT ZZ
4112 PRINT
4113 PRINT " NO    DATE    ESTABLISHMENT             AMOUNT    BALANCE"
4114 PRINT NUM(Z);TAB(5);DATE$(Z);TAB(14);ESTAB$(Z);TAB(36);AMNT(Z);TAB(48);CBAL
4115 PRINT
4120 IF NCHKS=101 GOTO 4130 ELSE RETURN
4125 IF ESTAB$(1)="**DEPOSIT**" THEN IBAL=IBAL+AMNT(1) ELSE IBAL=IBAL-AMNT(1)
4130 FOR Z=1 TO NCHKS-1
4140 Z1=Z+1
4150 NUM(Z)=NUM(Z1)
4160 DATE$(Z)=DATE$(Z1)
4170 ESTAB$(Z)=ESTAB$(Z1)
4180 AMNT(Z)=AMNT(Z1)
4190 NEXT Z
4200 RETURN
```

Ever had trouble getting the bank's statement of your checking account to correspond to that jumble of figures in your checkbook? Are you tired of trying to discern who check 565 was for? Well, if the answer to either question is yes, here is some help. The routine shown here is a checkbook maintenance routine. You can use it to verify your balance when you receive the monthly mystery, otherwise known as a bank statement, and, if you are fortunate enough to have a floppy or Phi-deck system, you can maintain a continuous record of your checking account.

After you have entered the program (by the way, this program was developed using TDL's 8 K Zapple BASIC) you will find that using it is quite easy. However, there are a few idiosyncracies you should be aware of. First, the check data is entered by supplying the number of the check, its date of issue, the party to whom the check was issued, and the amount of the check. This data is entered when the prompt message.

```
ENTER CHECK OR DEPOSIT DATA?
```

is displayed. For example:

```
ENTER CHECK OR DEPOSIT DATA?105,01/23,DR X,50.43
```

Note that the date was entered as a 5 character field; failure to follow this format (XX/XX) will result in an error. Also note that 30 characters have been allotted for the establishment to which the check was issued. Deposit data is entered in a similar manner, with the following exceptions: the check number should be 0 and the word DEPOSIT used for the establishment, for example:

```
ENTER CHECK OR DEPOSIT DATA?0,01/27,DEPOSIT,75.78
```

As each check or deposit is entered, it is placed in the file of existing check and deposit data. In this file all checks are stored in numerical order, with deposits being stored according to the date of deposit. All that you need to supply is the initial balance as requested and you'll be on your way.

Enough storage has been provided for 100 checks and deposits. However, for those of you who wish to increase (or decrease) this number, only two lines require modification. Line 10 defines the check and deposit file. These arrays must be one entry larger than the number of checks you want to accommodate. Line 4120 also requires modification to one more than the number of checks allocated in the file. Readers who have hard copy devices can change line 1060 to LPRINT, and the final listing of checks will be produced on your hard copy device. ■

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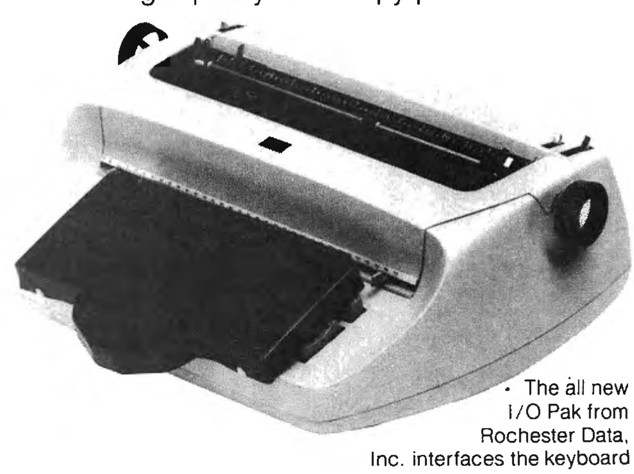

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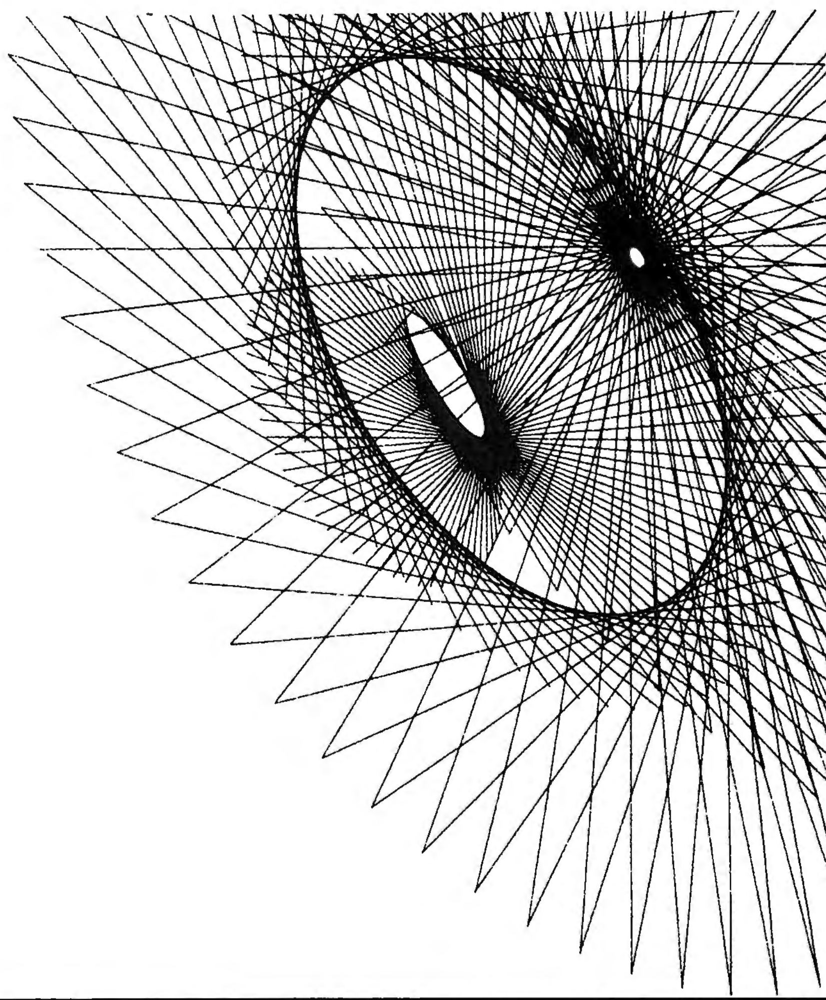

Computer graphics by Mike O'Shaughnessy

by Joseph Dawes

I've been in school for most of my life in one way or another. For more than 17 years now I have been a teacher of junior high and high school mathematics. My move from junior high school to high school was made thanks to a computer. Our school system had an opportunity to acquire a "teaching computer" because the company making it was right here in town. The idea was to put it in the high school and create a course of instruction in machine language computer programming for juniors and seniors. I was given the opportunity to develop and teach the course. The machine was ideal for the purpose, in that all registers were visible and manipulatable by the student. A Teletype was the only peripheral; but the students were not permitted to use it until they had learned enough to write the input-output (I/O) routines. We did a lot with a half year course and 1 K of memory. We took quite a few students all the way from machine language programming, through assemblers, to a compiler written by students, and proudly turned out several students who found their niche and became professional computer people in one way or another.

It's all past history now. We began this program in 1967, when school operating funds were much easier to come by, and it died seven years later for lack of financial support. (The old computer is far from dead, although its drum memory makes funny little sounds when we fire it up for old times' sake.) My desire to use a computer for educational purposes is also still alive, and now, thanks to inexpensive and highly capable microcomputer systems, I've got a second chance.

For nearly three years now I've had my microcomputer system with two cassette interfaces and a Teletype interface, video, and now running 20 K. My rationale for the purchase was to prepare a pilot program for preparing school attendance and grade reports in order to demonstrate to my school system that the new small, low cost computer systems were indeed capable of performing productive work. I am at work on this project now; and if it proves successful then we will once again have a chance to introduce students to hands-on computer operation, while at the same time serving some of the school system's computing needs locally.

All the preceding is preamble to one point I feel is worth making to many of you personal computer enthusiasts who have acquired your computer, got it tied in to your burglar alarm system, played all the games you can stand, and have just recently

My desire to use a computer for educational purposes is still alive, and now, thanks to inexpensive and highly capable microcomputer systems, I've got a second chance.

come to the realization that you are in imminent danger of displaying "The Topsy Syndrome."

> *I can't think of anything constructive to do with my computer so I'll implement APL and if it still doesn't do anything I'll get a joystick and if it still doesn't come up with something useful then some floppies to create virtual megabyte memory are bound to chase some terrific applications out of the wiring and if that doesn't do it then a super graphics board and voice synthesis and . . . .*

Perchance you feel a little uneasy with your accumulation of hardware and software. What good are fancy translators, compilers, assemblers, disassemblers, and interpreters if, after all, they benefit no one and result in no more productive programming than before?

Consider this alternative for getting off the expansion merry-go-round: use your computer for education; start with simple primary education. It doesn't take much memory; one cassette is sufficient, and a video interface would top it off. Use your computer to teach children some things they need to know to be more successful in their school studies. Start with your own children but if you don't have children of your own, use someone else's. Volunteer to take your machine to your local elementary school during some teacher's arithmetic or spelling time. If you think of teaching, you'll think of endless useful applications for that tremendously powerful and sophisticated example of technological development in which you've invested. I can certainly understand that for many, the joy of computing is in the building of the system and in making it ever more complex with hardware and software innovations. It also seems true, however, that for many, this development of computer potential may be much easier to justify on a corporate capital improvements budget than on a family survival budget. Perhaps, the idea of involving your computer with education might gain your technological pride and joy an increased measure of acceptance, by your family and by the public-at-large.

The idea didn't occur to me immediately. I had been working for a month or two on my pilot programs for administrative purposes in the school,

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CIRCLE 25 ON INQUIRY CARD

I heard her talking about a spelling contest in class, so a few days later Compucius asked her to try spelling some words, and lo and behold, they were words she had been using that day, and the next day the words were different.

happily debugging like mad, when I began to realize that man does not live by debugging alone. I wanted to show it off with something working and useful.

My first grade daughter had had the key all along. I had been ignoring her questions about the new "typewriter" and the new "TV" and the link they could have with all those school practice papers she brought home every day. In about 30 minutes, thanks to a BASIC interpreter used in my machine, I had a simple tutorial program for first grade addition and subtraction. In five more minutes my 6 year old knew which keys to push to terminate inputs and was solving more addition and subtraction problems than she had ever done as an assignment.

I didn't think scoring would be proper but she told me she wanted to know how she did, so with a few minutes of appending we had her a score when she told the machine to stop. Machines are no fun unless they have personalities, so a few more lines were added and it was asking for her name and then using it on every response in a conversational manner. Now she quickly realized this machine had to cease being an *it*, so *Compucius* was born. Every night before bedtime the question was, "What does Compucius have for me tonight?" For a while I added crazy new twists to the addition and subtraction program to keep her on her toes and delighted, then a brand new program to practice her knowledge of inequalities, which were being introduced in the first grade. I heard her talking about a spelling contest in class, so a few days later Compucius asked her to try spelling some words, and lo and behold, they were words she had been using that day, and the next night the words were different. What fun!

I am now looking forward to her second grade year and the new challenges that await her there. They'll be starting to learn about fractions, so I am designing a program to introduce the concept of fractional parts to her. I'm looking forward even further — wait till she starts on sentence structure! I already know how I'm going to tackle that one.

As a subtle by-product of all this, she is becoming well acquainted with the typewriter keyboard. I also haven't forgotten the evening she mentioned her wish to "teach Compucius" like I did. She knows where all those antics come from but she doesn't know how I get them in there. Well, of course you can guess what my biggie tutorial is going to be. One evening this winter Compucius is going to say, "Hi Kathryn! Let's see if you can teach me how to add 1 and 1!" Where will it all end?

I do all my complex programming in machine language with the help of my machine's assembler, but these teaching and practice programs which I have been describing are simply and quickly written in BASIC, if your computer has that capability as most now do. They seem almost too simple to write about and I venture to do so only because of the interest and kind comments they received from many people to whom I've shown them. Husbands take note, many wives tried them and went away saying, "That would be just the thing for our child."

Want to keep your computer young and active? Try what most teachers know — give it some contact with young people and let it help them. Remember, a teacher is forever! ■

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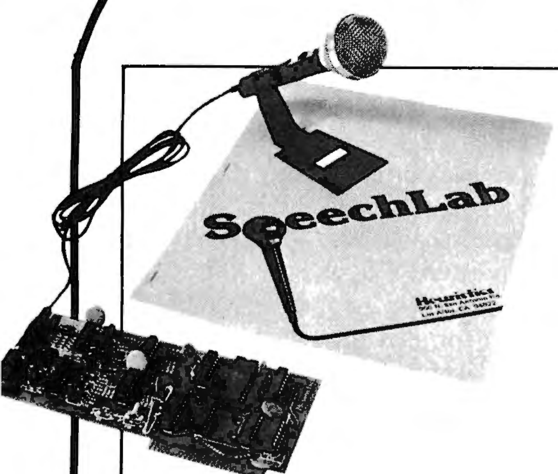


Voice Input for Apple II Computer

A voice data input unit for the Apple II computer is available from Heuristics Inc, 900 N San Antonio Rd, Los Altos CA 94022.

Speechlab Model 20A features a 32 word vocabulary, fast response and multiple training samples for accuracy. The program which runs the unit is contained on an onboard programmable read only memory and is automatically executed by the Apple II monitor program when speech input is desired.

A high fidelity microphone and a user manual with six demonstration programs (including Mastermind, Blackjack and Shooting Stars) written in Apple BASIC are included. The price is $189. ■

Nonimpact Desktop Printers

The Centronics Microprinter is a high speed, desktop, nonimpact printer available in parallel (Model P1) and serial (Model S1) interface versions. The primary difference between the two models is the inclusion of an RS-232C serial interface and 192 character FIFO buffer in the Model S1 for use through serial I/O ports of small computers.

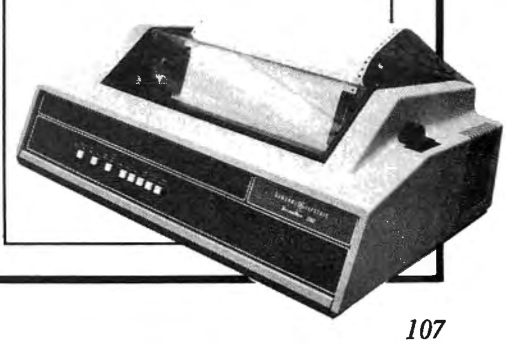
It prints 5 by 8 dot matrix characters at a rate of 150 lines per minute. The paper carries a conductive aluminized coating which is vaporized by a low voltage discharge from the print head to produce highly readable characters.

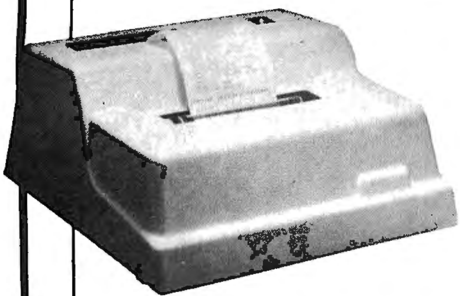
The price of the Model P1 is $495 and the Model S1 is $595. Contact Centronics Data Computer Corp, Hudson NH 03051. ■

Complete Matrix Printers

Two matrix printers are available from General Electric Data Communication Products in both interactive and line printer versions. The interactive 1200 bps KSR (keyboard send-receive) unit is mated with an RO (receive only) configuration which can be modified to serve as a line printer with minimal hardware changes. Some of the major features of the TermiNet 200 printers include: servo control for both carriage and paper advance, 20 inch per second slew rate, a 1 K byte buffer, multipart forms printing, 136 column print positions with variable character spacing, selectable vertical spacing, tractor adjustment, and the ability to handle paper widths from 2 to 16½ inches. The operator replaceable print head has a 7 by 9 dot matrix which provides clear character resolution in both single and multiform usage.

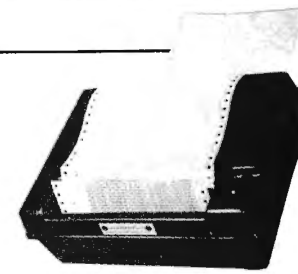
Single unit pricing is about $3000. For further information, contact General Electric Data Communication Products, Waynesboro VA 22980. ■





Impact Matrix Printer

The Series 40 printers from Micro Peripherals Inc, 2099 W 2200 South, Salt Lake City UT 84119 feature low cost, 40 column hard copy. They are impact printers which produce dot matrix characters at a speed of 75 lines per minute. According to the company, the peak printing rate is 129 characters per second. Each printer is completely self-contained, including its own electromechanical components, control logic, pattern generation, buffering and power supply. The Series 40 printers range in price from $425 to $650. ■



Expandor's Black Box Printer

The Black Box Printer is a lightweight, portable, quiet, impact printer that prints 80 columns wide, at 10 characters per second, on 8½ inch wide pressure fed or sprocket fed paper. Up to five copies may be printed at one time. The Black Box Printer features a single case 64 character ASCII character set. The printer is $396 and the base and cover are an additional $29.95. Contact Expander Inc, 400 Sainte Claire Plaza, Upper St Clair PA 15241. ■

Computer Graphic Input Device

The Digi-kit-izer computer input peripheral opens the door to the world of graphics for the small systems owner. According to the manufacturer, it can be assembled from a kit in one evening. The applications include architecture, cartography, mathematical analysis, motion picture film generation, and medical and dental analysis. The Digi-kit-izer has an active surface area of 11 by 11 inches and a resolution of 200 lines per inch. The data rate is 100 coordinate pairs per second and it is switch selectable from point to continuous operating modes. The transducer is a pen-type stylus and the unit never needs alignment or calibration.

The utility of the Digi-kit-izer is enhanced by an RS-232 interface option with selectable data rates and a high resolution Apple interface board. Interface boards to the TRS-80 and IMSAI are also available. It is priced at $449 and available from Talos Systems Inc, 7419 E Helm Dr, Scottsdale AZ 85260. ■

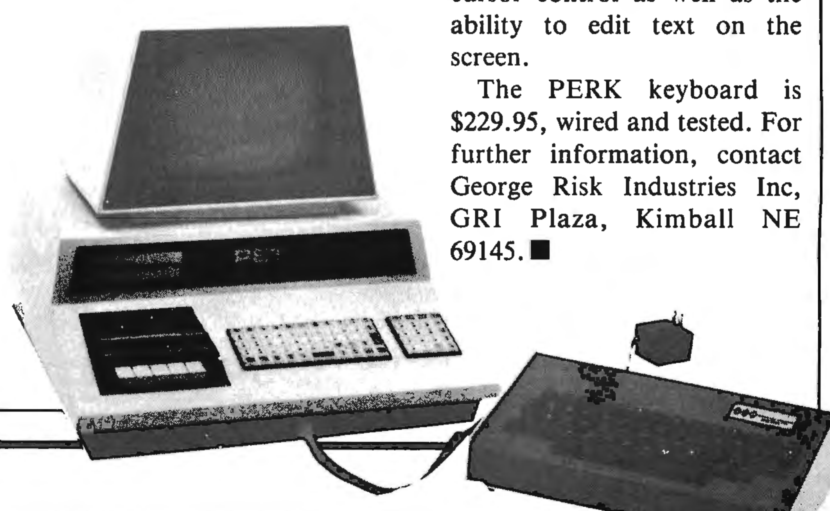
Keyboard Enhances Operation of Commodore PET

The professional encoded Remote Keyboard (PERK) for the Commodore PET computer is a plug-in, typewriter style, alphanumeric keyboard, designed to enhance the operation of the PET. The PET comes with a built-in calculator type keyboard, but the keys of this board are only half the size of standard typewriter keys.

The PERK keyboard shares the PET internal keyboard interface, allowing the two keyboards to be used interchangeably. Both are active at all times, allowing the operator to use the PERK keyboard for normal data entry, and the PET keyboard for numerics or graphics.

The PERK is connected by means of a plug-in interface card. It gives the user complete cursor control as well as the ability to edit text on the screen.

The PERK keyboard is $229.95, wired and tested. For further information, contact George Risk Industries Inc, GRI Plaza, Kimball NE 69145. ■



Software Packages

Personal Software has published a catalog which covers entertainment and self-education, personal finance, home information management and a variety of hobbies. The software available includes: Stimulating Simulations, a set of ten games that simulate a situation that may be realistic or fanciful; Microchess, which enables the user to play chess against a TRS-80 computer; assembler in BASIC to make it possible to write programs in assembly language for the 6502 processor and have them translated to machine language for direct execution on the PET; and a Word Processing Package for PET owners who would like to compose and edit letters, articles and manuscripts, and obtain corrected output at high speed. For a copy of the catalog write to Personal Software. POB 136, Cambridge MA 02138. ■

Software Handbook of Statistical Techniques

This software handbook, *SIMPLE,* contains over 100 conversational computer programs in BASIC, for teaching statistics and experimental design to students from engineering, science, business and social science disciplines. It also includes descriptions of the programs, input and format requirements, sample problems, and copies of terminal/user dialogues.

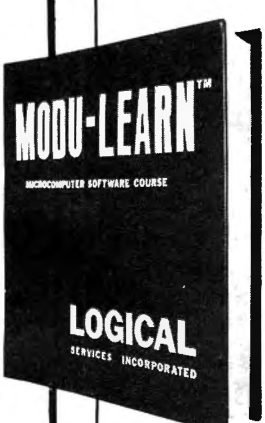
The price is $10.95 from Sterling Swift Publishing Company, POB 188, Manchaca TX 78652. ■

Foreign Language Vocabulary Programs

Foreign Language Vocabulary is a bidirectional program for the instruction, practice and testing of language vocabulary skills. The program is written in BASIC and languages include French, Spanish, Italian and German.

Program features include separate modes for vocabulary instruction, practice drills and testing, selectable by the user. The user may also alternate language direction (English to French, or French to English) to improve comprehension. The Educator option permits the creation of files for the storage of student identification, text responses and test scores, for use in a classroom situation.

Each volume is priced at $5 with the Educator option costing an additional $3. All four volumes are $17.50 or $27.50 with the Educator option. Contact Musgrove Engineering, 9547 Kindletree Dr, Houston TX 77040. ■



Microcomputer Programming Home Study Course

A course in microcomputer programming for beginners is available from Logical Services Inc, 1080H E Duane Av, Sunnyvale CA 94086. *Modu-Learn* presents systematic software design techniques and structured programming in ten lessons complete with problems, solutions, and practical examples in 8080 and 8050 assembly language. Background material on microcomputer architecture, hardware and software trade-offs and useful reference tables are included in this book of over 500 pages. It is bound in a notebook for easy reference.

The price is $49.95. Write to the company for a free brochure and course outline. ■

Software for the H8

Two tapes are available for the Heathkit H8 computer from Ed-Pro Inc, 6580 Buckhurst Trl, Atlanta GA 30349. One tape contains 11 game programs; the other contains programs for checkbook reconciliation, budgeting and calculation of interest for loans and investments. Tapes are supplied with complete program listings and user instructions. Tapes sell for $20 each (with a 10% discount if both are purchased). ■

Expanded Book Catalog from BITS

An expanded BITS catalog is available featuring books on microcomputing and other related subjects. There are books on business and calculators, Pascal, artificial intelligence, robotics, programming, hardware, games and much more.

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Free Guide to Personal Computers from NCE

A helpful book on personal computers is being offered free to readers of onComputing by NCE/CompuMart Inc, 1250 N Main St, POB 8610, Ann Arbor MI 48107. *Getting Started in Microcomputers* evaluates 25 books and periodicals on current technology and equipment. This illustrated paperback also includes a buyer's guide with information on current prices, capabilities and expansion possibilities of personal computers. To receive your free copy, write to NCE/CompuMart at the above address. ■

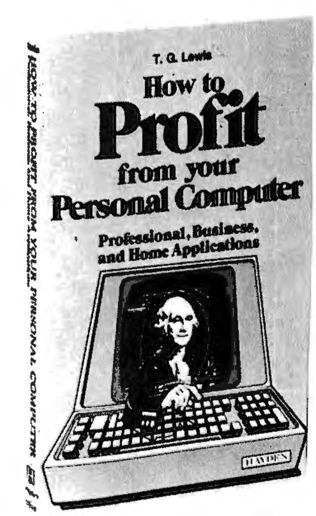
Computer Selection and Operation for Small Businesses

Management Information Corp's publication, *How Small Businesses Use Computers*, is a 40 page collection of case studies, which includes the reasons why each small business decided to implement computers, and describes the operation of each installation.

The report delves into the factors that cause a small company to acquire a computer system, ranging from high labor costs or inability to use service bureaus to increased efficiency. The management of each company's system is stressed, including supervision, advanced training of operators and the maintenance program.

This complete set is being offered for $15. Contact MIC, 140 Barclay Center, Cherry Hill NJ 08034. ■

Put a Personal Computer to Work for You



The profitable uses of personal computers are detailed in this 191 page book published by Hayden Book Company Inc, 50 Essex St, Rochelle Park NJ 07662. *How to Profit from Your Personal Computer by* T G Lewis is of interest to the small business owner or professional who is now overwhelmed with paperwork and desires a simpler system. It describes the uses of personal computers in common business applications, such as accounting, handling payrolls, managing inventory and sorting mail lists. It will help you in selecting equipment; in analyzing a problem for a business, hobby or educational application; and in translating your solutions into real computer systems.

The book teaches how to configure a system to fit the needs of an application and how to implement that system using programming techniques developed by the author. Programs in BASIC and blueprints of each program are included. The book uses terms, notations and techniques commonly used by programmers.

How to Profit from Your Personal Computer will give you a better understanding of the fundamentals of data processing. It is priced at $7.95. ■

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Automotive Computer

This automotive computer displays such data as miles to go, vehicle location, estimated arrival time, miles per gallon, cost per mile and 19 other functions. The Prince On-Board Computer is easily installed by connecting a speed transducer and fuel flow transducer, both supplied.

It includes a memory scan and an alarm which sounds one mile before reaching a programmed location.

The unit retails for about $400. Contact Prince Corp, POB 6, Holland MI 49423. ■

Outthink the Computer With COMP IV

COMP IV is a game in which the player tries to outthink the computer. The challenge to the player is to deduce a secret number selected by the instrument's circuitry. The player may elect to discover a 3, 4, or 5 digit number.

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COMP IV retails at approximately $29.95. Contact Milton Bradley Co, Springfield MA 01101. ■

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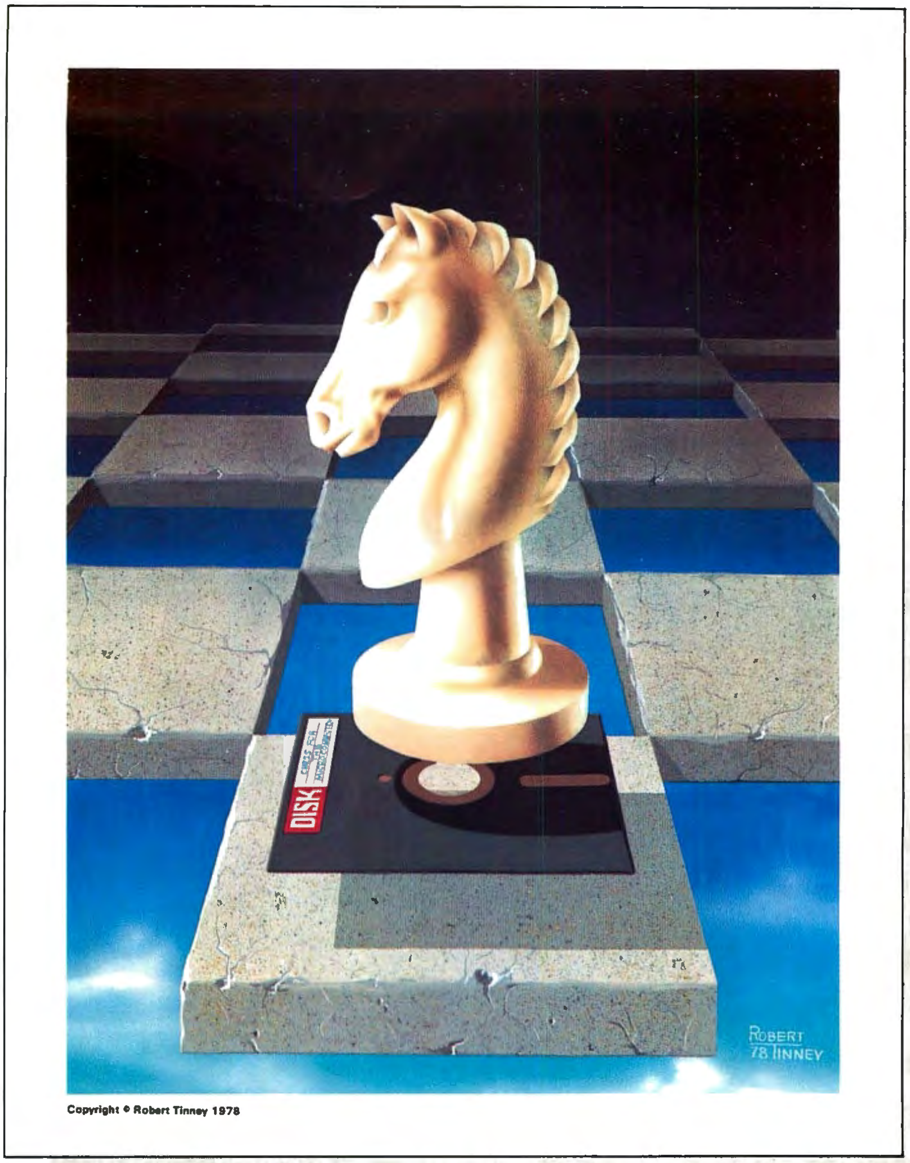

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